Lernen und Kompetenzentwicklung im dynamischen Umfeld klinischer Arbeit. Zusammenspiel und Bedeutung von Lern- und Arbeitsprozessen sowie technologischen Artefakten in medizinisch-klinischen Kontexten

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Prof. Dr. Norbert Pachler

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Bibliographischer Nachweis

Artikel 1: Pimmer, C., Pachler, N., Nierle, J., & Genewein, U. (2012). Learning through inter-and intradisciplinary problem solving: using cognitive apprenticeship to analyse doctor-to-doctor consultation. Advances in Health Sciences Education, 17(5), 759-778.

Artikel 2: Pimmer, C., Pachler, N., & Attwell, G. (2010). Towards Work-Based Mobile Learning: What We Can Learn from the Fields of Work-Based Learning and Mobile Learning. International Journal of Mobile and Blended Learning, 2(4), 1-18.

Artikel 3: Pimmer, C., Linxen, S., Gröhbiel, U., Jha, A., & Burg, G. (2012). Mobile learning in resource-constrained environments. A case study of medical education. DOI:10.3109/0142159X.2012.733454. Medical Teacher.

Artikel 4: Pimmer, C., Linxen, S., & Gröhbiel, U. (2012). Facebook as a learning tool? A case study on the appropriation of social network sites along with mobile phones in developing countries. British Journal of Educational Technology (Special Edition), 43(5), 726-738

Artikel 5: Pimmer, C., Pachler, N., & Genewein, U. (2013). Contextual dynamics in clinical workplaces. Learning from doctor-to-doctor consultations. Med Educ, 47(5), 463–475

Artikel 6: Nicht veröffentlicht: Pimmer, C., Pachler, N., & Genewein, U. Learning and teaching processes in clinical work and problem solving.

Artikel 7: Medical practice as distributed cognition. Re-framing clinical workplace learning: Final version: Pimmer, C., Pachler, N., & Genewein, U. (2013). Reframing Clinical Workplace Learning Using the Theory of Distributed Cognition. Academic Medicine, 88(9), 1239–1245.

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Rahmenpapier

Abstract

Die vorliegende Dissertation widmet sich in Form mehrerer kumulativer Beiträge dem Thema Lernen und Kompetenzentwicklung im dynamischen Kontext klinischer Arbeit. Der Fokus dieser interdisziplinären Arbeiten liegt an der Schnittstelle der Forschungsfelder *Education, Scientific Disciplines, Education & Educational Research* sowie *Health Care Sciences & Services* (Thomson Reuters, Citation Reports®).

Primärer Untersuchungsgegenstand der explorativen qualitativen Studien war Lernen und Kompetenzentwicklung von medizinischen und klinischen Akteuren, d.h. von Medizinstudierenden, Assistenzärzten als auch Ober- und Fachärzten. Auf Basis umfangreicher Forschungsarbeiten, die mit semistrukturierten Einzelinterviews, Fokusgruppen, Dokumentanalysen, teilnehmender Beobachtung und "shadowing" ein sehr breites Spektrum qualitativer Erhebungsmethoden in vier Schweizer und zwei nepalesischen Spitälern umfassten, wurde dieser Themenbereich in vielschichtigen inhaltlichen und theoretischen Dimensionen weiterentwickelt. In den Arbeiten werden die dynamischen Wechselwirkungen von Kontextfaktoren und Lehr-/Lernprozessen am Beispiel interdisziplinärer Zusammenarbeit in Konsilien aufgezeigt sowie die Bedeutung von Technologien als Lernwerkzeuge für die genannten Zielgruppen in unterschiedlichen organisatorischen und kulturellen Kontexten analysiert. Zudem wird gezeigt, dass für ein zukünftig besseres Verständnis von klinischer Kompetenzentwicklung die Analyse des Zusammenspiels vielfältiger, miteinander eng verwobener, multimodaler Repräsentationen (wie z.B. Sprache, visueller und haptischer, körperlicher und IT-artefaktbasierter Strukturen) notwendig ist. Die einzelnen Arbeiten sind aus sozio-kognitiven, sozio-kulturellen und situierten Perspektiven theoretisch fundiert und haben zur Weiterentwicklung bestehender resp. zur Generierung neuer theoretischer Bezugsrahmen geführt.

Indem zum Zeitpunkt der Einreichung sechs der sieben Artikel in den führenden Journals der genannten Forschungsfelder akzeptiert wurden, konnte ein massgeblicher Beitrag zur Weiterentwicklung des Forschungsstandes geleistet werden. Zum Beispiel wurden Beiträge in *Academic Medicine* (Impact 2011: 3.524, Rang 1 Education, Scientific Disciplines, Rang 6 Health Care Sciences & Services nach Thomson Reuters, Citation Reports®), in *Medical Education* (Impact 2011: 3.176, Rang 2 in Education, Scientific Disciplines*)*, in *Advances in Health Sciences Education (Impact 2011: 2.089, Rang 3 in Education, Scientific Disciplines)* oder im *British Journal of Educational Technology* (Impact 2011: 2.098, Rang 12 Education & Educational Research) angenommen resp. publiziert.

Neben der wissenschaftlich-theoretischen Relevanz weist die Dissertation praktische Bezüge auf und erlaubt konkrete Schlussfolgerungen hinsichtlich Gestalt und Gestaltung klinischer Kompetenzentwicklung. Von besonderer bildungspolitischer Bedeutung sind jene Beiträge, die, im Kontext der Millennium-Development-Goals, aufzeigen, auf welche kreative und selbstbestimmte Weise sich medizinische Akteure in Transitions- und Entwicklungsländern Mobiltechnologien und soziale Medien für Lernzwecke aneignen. Diese Arbeiten riefen im internationalen Kontext grosses Interesse hervor. So wurde der Autor eingeladen, die Ergebnisse politischen und wirtschaftlichen Entscheidungsträgern, NGOs und internationalen Organisationen, wie z.B. WHO, UNESCO, ITU oder

USAID, am *World Summit on the Information Society* (Genf) und bei dem *United Nations-Gipfel GEThealth* (New York) vorzustellen - mit dem Ziel, die Erkenntnisse in globale, nationale und regionale Initiativen wie Strategie- und Technologieentwicklungsprozesse einfliessen zu lassen.

Im vorliegenden Rahmenpapier werden die wissenschaftlichen und praktischen Beiträge der einzelnen Arbeiten aufgezeigt und zueinander in Beziehung gesetzt. Während die Leistungen hier zusammenfassend dargestellt werden, finden sich die Details der einzelnen Forschungsvorhaben und -ergebnisse in den beigelegten Publikationen.

Inhaltsverzeichnis Rahmenpapier

Thematische, theoretische und praktische Erkenntnisse

In den folgenden Abschnitten werden die wesentlichen thematischen und theoretischen Leistungen der Dissertation zu den Forschungsfeldern der medizinischen Bildung sowie die praktische Relevanz der Arbeiten zusammenfassend dargestellt.

Die Dynamiken von Lern- und Lehrprozessen

Bislang wurden Lern- und Entscheidungsprozesse im Bereich der medizinischen Bildung vielfach aus kognitiver Perspektive untersucht (siehe z.B. Eva, 2005; Norman, 2005). Weit weniger bekannt ist, in welche sozialen Praktiken kognitive klinische Lehr- und Lernprozesse eingebettet sind und welche Dynamiken ihnen dabei zugrunde liegen. In den Publikationen 1 und 6 wurden, anhand der Analyse von interdisziplinären ärztlichen Konsilien, soziale und kognitive Perspektiven integriert, und – auf empirischer Basis – theoretische Bezugsrahmen, resp. Theorieentwürfe (siehe Absatz Ergebnisformen: Theorie-Entwicklungen) für klinische Lehr- und Lernprozesse weiterentwickelt resp. erarbeitet. Konsilien sind Prozesse, in denen eine Ärztin oder ein Arzt in einem Klinikum zur Behandlung eines komplexeren Patientenfalles einen oder mehrere weitere medizinische Fachspezialisten, (im Folgenden als "Experten" bezeichnet), beizieht.[1]

In Beitrag 1 wird zunächst eine Analyse von Lehr- und Lernprozessen in Konsilien auf Basis des "cognitive-apprenticeship"-Ansatzes durchgeführt. Diese Theorie propagiert sechs verschiedene instruktionale Methoden, mit denen ein Experte die Lernenden in ihrer Kompetenzentwicklung unterstützen kann: "modelling", "coaching", "scaffolding", "articulation", "reflection" und "exploration" (Collins, Brown & Holum, 1991). Während "cognitive apprenticeship" und die entsprechenden instruktionalen Methoden bisher in formellen Lernkontexten mit expliziten didaktischen Strukturen angewandt und erforscht wurden (Stalmeijer, Dolmans, Wolfhagen & Scherpbier, 2008; Stalmeijer, Dolmans, Snellen-Balendong, van Santen-Hoeufft, Wolfhagen & Scherpbier, 2012; Woolley & Jarvis, 2007), zeigt die Publikation 1 den Beitrag dieser Theorie in alltäglichen Arbeitsprozessen, und somit in informellen Lernkontexten, auf. In der Analyse stellte sich heraus, wie, ausgehend von explorativem Problemlösen (Exploration), darauffolgenden Interaktionen mit erfahreneren Ärzten in Form von "articulation", "modelling", "coaching" sowie Reflexionsprozessen ("reflection") Lernen in Konsilien mit den Methoden des "cognitive apprenticeship" erklärt werden kann (siehe Abbildung 1). Einerseits wird dadurch die Lernrelevanz von Konsilien ersichtlich. Anderseits machen die Ergebnisse auch die Eignung des "cognitive apprenticeship" für informelle, arbeitsprozessorientierte Lernkontexte evident – wenngleich nicht uneingeschränkt: So wurden in Bezug auf die Disjunktion (z.B. Unterscheidbarkeit von "coaching" und "scaffolding), auf die Sequenzierung und die Vollständigkeit der Methoden Defizite identifiziert.

[1] Als Experten werden Ärzte bezeichnet, die mehr oder spezifischere Erfahrung im Vergleich zu "Lernenden" aufweisen. Das können z.B. Oberärzte einer Abteilung, oder aber auch Assistenz- und Oberärzte als Fachspezialisten aus einer anderen Abteilung sein. Damit wird deutlich, wie dynamisch die Rollen von Experten und Lernenden sind. Ärzte können in einer Situation als "Experten" und in der nächsten Situation als "Lernende" agieren. Ebenso soll angemerkt werden, dass ärztliche Akteure auch in der Rolle von Experten lernen können.

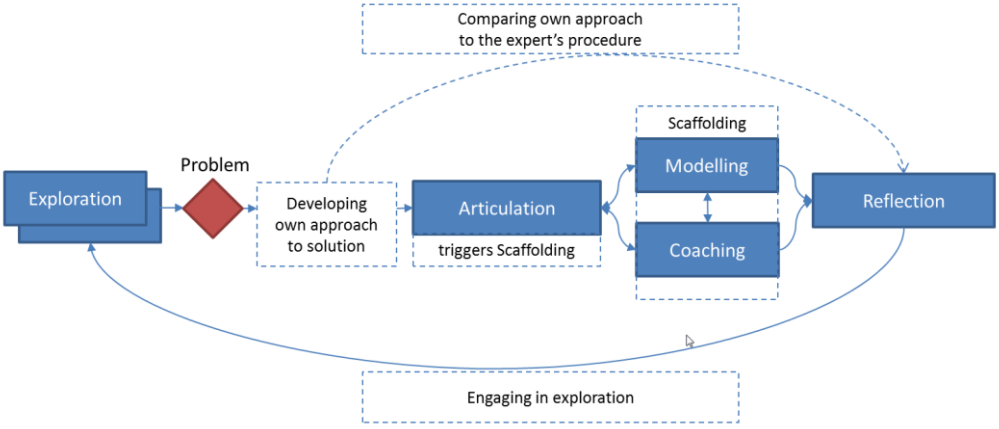

Abbildung 1 Methoden des "cognitive apprenticeship" in informellen klinischen Lernkontexten am Beispiel von Konsilien (Pimmer et al., 2012c)

In Beitrag 6 wurde auf Basis weiterer empirischer Untersuchungen versucht, einen umfassenderen und für klinische Kontexte kohärenteren Theorieentwurf zu entwickeln. Auf Basis situierter und informeller Lernperspektiven wurde eine weitgehend induktive Theorieentwicklung vorgenommen (vgl. Abbildung 2). Aus dem entwickelten theoretischen Bezugsrahmen geht hervor, wie Lernende (d.h. in der Regel Assistenzärzte) in explorativen Prozessen relativ eigenständig Patienten untersuchen, (mentale) klinische Schlussfolgerungen und Konzeptionen erarbeiten ("clinical reasoning") und allenfalls auf kodifiziertes Wissen aus Büchern oder dem Internet zugreifen. Um, wie in einem Konsilium notwendig, Experten beizuziehen, müssen Lernende die eigenen Konzeptionen diesen gegenüber zuerst artikulieren. Im hektischen klinischen Alltag ist die Teilnahme von Lernenden an Situationen mit Experten keineswegs selbstverständlich. Lernende müssen solche Konstellationen pro-aktiv arrangieren und können die Experten schliesslich bei der Patientenbehandlung beobachten oder ihnen bei der Artikulierung des Wissens zuhören. Um eine Situation der Involvierung in eine explizite Lehrsituation ("teaching") zu verwandeln (vgl. Abbildung 2), können die Lernenden durch gezielte Fragen ihre Motivation und ihr Interesse zum Ausdruck bringen und somit Lehrprozesse von Seiten der Experten stimulieren. Dabei empfinden die befragten Personen es als günstig, wenn die erfahrenen Ärzte die Lernenden einerseits durch gezielte Fragestellungen herausfordern und, andererseits, durch mündliche Erklärungen sowie Gesten und physische Demonstrationen unterstützen. Die Prozesse der Involvierung und des expliziten Lehrens erlauben den Lernenden, ihre eigenen Konzeptionen mit jenen der Experten zu vergleichen und zu modifizieren.

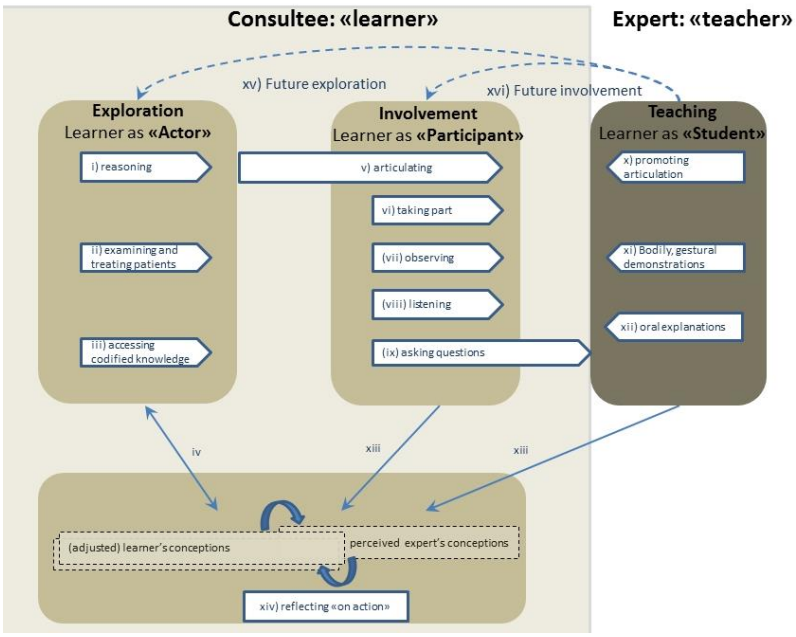

Abbildung 2 Das dynamische Zusammenspiel von Lern- und Lehrprozessen am Beispiel von Konsilien (Pimmer et al., submitted)

Der entwickelte theoretische Bezugsrahmen zeigt die Dynamik und Reziprozität von Lehr- und Lernprozessen in den einzelnen Lernsituationen und darüber hinaus. Einerseits wird durch den Prozess der Artikulation aus einer explorativen Lernsituation eine der Involvierung; und gezieltes Nachfragen von Seiten der Lernenden kann eine Situation der Involvierung in ein Setting mit explizitem Lehrcharakter verwandeln. Anderseits wirken sich Existenz und Qualität der Lehrprozesse nicht nur auf das gegenwärtige Lernen, sondern auch auf zukünftige Formen der Exploration und der Involvierung aus.

Einzelne Aspekte der Untersuchung knüpfen an eine Reihe von vorliegenden Studien aus dem medizinischen Bildungsbereich an. Der entwickelte Theorieentwurf kann auch mit der von Eraut (2007) entwickelten Typologie des "early career learning" verglichen werden. In dieser Typologie wird eine Konsultation als ein spezifischer Prozess unter "work processes with learning as a by-product" subsumiert. Der Beitrag 6 zeigt, im Kontrast dazu, wie reichhaltig und vielfältig interdisziplinäre Konsultationen (Konsilien) in klinischen Kontexten sein können. Ebenso erweitert und detailliert der erarbeitete theoretische Bezugsrahmen die Methoden des "cognitive apprenticeship" durch die Identifikation verschiedener Prozesse der Exploration. Viel entscheidender ist jedoch, dass in den Beiträgen 1 und 6 die Dynamiken und reziproken Zusammenhänge verschiedener Lehr- und Lernprozesse aufgezeigt werden. Das sind Aspekte, die bei den genannten theoretischen Ansätzen bisher wenig Berücksichtigung fanden.

Die Wechselwirkungen zwischen Kontext und Lernen

Während in vielen Berufsfeldern, wie z.B. in der Geographie, der Architektur, der Anthropologie oder in den Computerwissenschaften dem Begriff "Kontext" grosse Bedeutung beigemessen wird, nimmt dieses Konzept in der Bildungs- und Lernforschung bisher eine eher untergeordnete und theoretisch wenig fundierte Rolle ein (Luckin, 2010). Im Bereich der medizinischen Bildung wird auf die Rolle von Kontext für Kompetenzentwicklung hingewiesen (Epstein & Hundert, 2002). Dennoch wird auf die Notwendigkeit eines besseren Verständnisses von Kontext (als Lernumgebung) für die

Kompetenzentwicklung hingewiesen. Es wird gefordert, insbesondere dem Zusammenspiel verschiedener Kontextfaktoren grössere analytische Aufmerksamkeit zuteilwerden zu lassen. (Hoffman & Donaldson, 2004; Teunissen, Scheele, Scherpbier, Van Der Vleuten, Boor, Van Luijk & Van Diemen Steenvoorde, 2007).

Die wenigen vorliegenden Publikationen beschäftigen sich tendenziell mit dem Einfluss von Kontext auf das Lernen von Medizinstudierenden in klinischen Praktika (Boor, Scheele, Van Der Vleuten, Teunissen, Den Breejen & Scherpbier, 2008; Deketelaere, Kelchtermans, Struyf & De Leyn, 2006; Dornan, Boshuizen, King & Scherpbier, 2007; Seabrook, 2004; Sheehan, Wilkinson & Billett, 2005). Kaum Beachtung fand bisher das Zusammenwirken von Lernvorgängen und Kontext in lose gekoppelten Konstellationen im Rahmen täglicher Arbeitspraktiken ausserhalb formeller didaktischer Strukturen. Das sind Charakteristika, die sehr typisch für den klinischen Alltag sind. Diesem Wissensdefizit widmet sich die Studie 5. Auf Basis empirischer Analysen von Konsilien wurde hier ein theoretischer Bezugsrahmen erarbeitet (Abbildung 3). Dieser zeigt auf, wie das dynamische Zusammenspiel verschiedener Kontextfaktoren sowohl Form als auch Qualität von Lernrollen und -prozessen in jeder einzelnen Situation prägt und, über die Zeit hinweg, die Kompetenzentwicklung der Ärzte massgeblich beeinflusst.

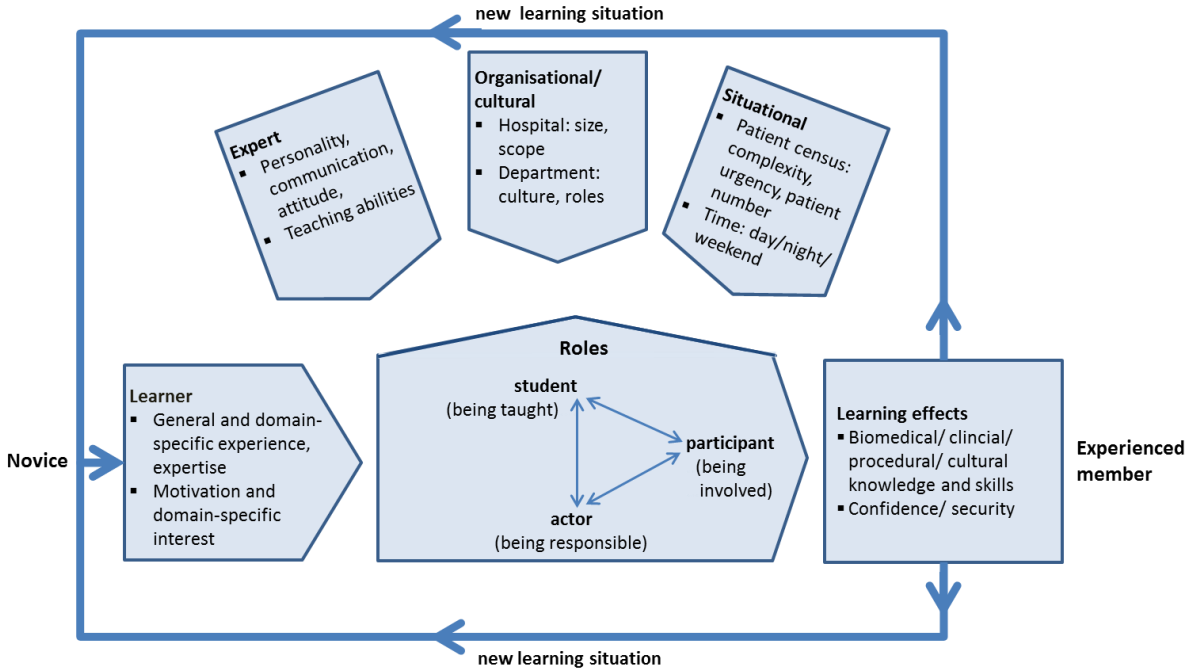

Abbildung 3 Lernkontext als die Interaktion von Einflussfaktoren am Beispiel von Konsilien (Pimmer et al., accepted-a)

Die identifizierten Einflussgrössen sind situativer, personeller und organisatorischer Natur: Individuelle Faktoren umfassen Konzepte wie Motivation, Fach- und Fallinteresse sowie die Fach- und Fallerfahrung des Lernenden. Auf Seite der Experten wirken insbesondere deren Persönlichkeiten und grundsätzliche Kommunikationseinstellungen sowie ihre didaktischen resp. instruktionalen Fähigkeiten; organisatorische und kulturelle Faktoren sind die Grösse und die Ausrichtung des Spitals sowie die Kultur in den Fachabteilungen und die Organisation der Rollen in Konsilien. Situative Einflussgrössen - das sind Faktoren, die von Situation zu Situation sehr unterschiedlich ausgeprägt sein können - betreffen Anzahl, Dringlichkeit und Komplexität der zu bearbeitenden Fälle sowie

Tages-/Nachtschicht. Das Zusammenspiel der genannten Faktoren manifestiert sich in drei verschiedenen Rollen, die Ärzte in sehr dynamischer Weise einnehmen: Sie lernen als "Akteure", indem sie selbständig Aufgabenstellungen bewältigen; als "Teilnehmende", wenn sie in lernrelevanten Situationen mit erfahrenen Akteuren involviert sind; und als "Studierende", wenn sie gezielte instruktionale Unterstützung in einer expliziten Lehrsituation erfahren. In den einzelnen Konsilien eignen sich Ärzte biomedizinische, klinische sowie kulturelle und methodische Fertigkeiten und Wissen an. Ebenso werden ihr Selbstvertrauen und die Fähigkeit zur Selbsteinschätzung beeinflusst. Ärzte lernen jedoch nicht nur aus Situationen, in denen sie von Experten bestätigt werden; als besonders einprägsam und lernrelevant erachteten sie jene Fälle, in denen ihre Einschätzungen und Konzeptionen nicht mit jenen der erfahrenen Ärzte übereinstimmen, was möglicherweise zu einem Fehler geführt hätte.

Die Rolleneinnahme erfolgt sehr dynamisch, von Moment zu Moment, und ändert sich im Laufe der assistenzärztlichen Kompetenzentwicklung. Mit der Zeit kumulieren die Lerneffekte einzelner Konsilien zu allgemeiner und spezifischer Fach- und Fallerfahrung; und die Ärzte lernen zunehmend in der Rolle von "Akteuren". Im Hinblick auf ihre Lernrelevanz sind die Rollen komplementär und sollen nicht gegeneinander ausgespielt werden. Viel entscheidender ist die Qualität des Lernens innerhalb der Rollen, die, wie in Beitrag 5 veranschaulicht wird, wiederum von Kontextfaktoren beeinflusst wird. Während der erarbeitete theoretische Bezugsrahmen neu ist, integriert er wichtige Erkenntnisse aus früheren Studien. Eine wichtige Bezugsbasis stellen die Theorieentwürfe von Dornan et al., (2007) und Boor et al., (2008) dar, die Einflussfaktoren beim Lernen von Medizinstudierenden beleuchten. Im Vergleich dazu kommen in der Analyse von Beitrag 5 keine curricularen Faktoren zum Vorschein. Anstelle dessen bildet die nicht-lineare Interaktion (vgl. dazu Durning, Artino Jr, Pangaro, Van Der Vleuten & Schuwirth, 2010) von organisationalen, individuellen und situativen Einflussgrössen das "Curriculum des Arbeitsplatzes".

Technologien und "Tools" für Kompetenzentwicklung

Mit der Nutzung von Technologien als Lernwerkzeuge adressiert die Dissertation ein weiteres wichtiges Thema, dem bisher in der Literatur zu wenig Aufmerksamkeit geschenkt wurde. Das Gros der vorliegenden Publikationen konzentriert sich auf den Einsatz und die Wirkung von E-Learning mit expliziter didaktischer Ausrichtung (Cook, Levinson, Garside, Dupras, Erwin & Montori, 2008; Cook, Levinson, Garside, Dupras, Erwin & Montori, 2010; Curran & Fleet, 2005; Wutoh, Boren & Balas, 2004). Die Arbeiten haben jedoch aufgezeigt, dass in Infrastruktur- und ressourcenschwachen Regionen von Transitions- und Entwicklungsländern Mobiltechnologien, wie z.B. Handys und Smartphones, und soziale Netzwerke, wie z.B. Facebook, die sich Medizinstudierende und Assistenzärzte in informellen Lernkontexten für Bildungszwecke zu Nutze machen, eine wichtige Rolle bei der Kompetenzentwicklung einnehmen. In Publikation 3 werden auf Basis der "cultural historical activity theory" (CHAT) drei wesentliche mobiltechnologiegestützte Lernaktivitäten identifiziert (siehe **Abbildung 4**). CHAT ist eine Theorie, die von Engeström (2000; 1987, 1999, 2001) massgeblich weiterentwickelt wurde, und die im lernwissenschaftlichen Bereich, insbesondere bei technologiegestützten Interaktionsformen, grosse Popularität geniesst (Blin & Munro, 2008; Isssroff & Scanlon, 2002; Jonassen & Rohrer-Murphy, 1999; Nardi, 1996; Sharples, Taylor & Vavoula, 2007). Die Datenanalyse auf Basis von CHAT brachte drei Lernaktivitäten zum Vorschein: Mobiltechnologie erlaubt Lernenden (1) situiertes Lernen und "situated cognition", indem sie z.B. auf der Station, im Operationssaal oder in der Bibliothek per Mobilgerät auf virtuelle elektronische

Ressourcen zugreifen, die ihr situatives Verständnis (z.B. bei einem vorliegenden Patientenfall) erhöhen; (2) kontextübergreifendes Lernen, wenn Studierende situative Erfahrungen in Form von Bildern und Videos mit ihren Mobiltelefonen dokumentieren und danach zum Selbststudium, wie z.B. für eine Prüfungsvorbereitung, nutzen oder mit Studien- und Praktikumskollegen teilen und diskutieren; (3) Teilnahme an und Engagement in virtuellen, beruflichen Online-Communities, wie z.B. Facebook-Gruppen. Auf Basis von CHAT wurde analysiert, wie die Aneignung von technologischen (mobilen) Lernwerkzeugen zu Spannungen in Bezug auf Normen, Regeln, soziale Gemeinschaften ("communities") und auf die Arbeits-/Rollenteilungen führt und schliesslich Veränderungen im gesamten "activity system" bewirkt. Wie in Beitrag 3 zum Ausdruck kommt, gehen diese kulturellen und systemischen Veränderungen von den Studierenden und Assistenzärzten aus. Das ist eine Beobachtung, die auch in anderen Studien beschrieben wird (siehe z.B. Bleakley, 2002). Im Vergleich zu der im Untersuchungskontext vorherrschenden hierarchischen und lehrerzentrierten Kultur und der grossen Machtdistanz (Lemone, 2005), stellen die neuen "activities" die Lernenden in den Mittelpunkt der medizinischen Bildung und erhöhen ihre Handlungsfähigkeit ("agency"); d.h. ihre Möglichkeiten, auf soziokulturelle Strukturen und etablierte kulturelle Praktiken Einfluss zu nehmen und diese zu verändern (Pachler, Bachmair & Cook, 2010a). Gleichzeitig wird deutlich, dass im Untersuchungskontext formelle Lernelemente wie Hörsäle oder Lehrkräfte nicht mehr länger als "gatekeepers of knowledge and the personal expertise" erachtet werden können (Pachler, Cook & Bachmair, 2010b).

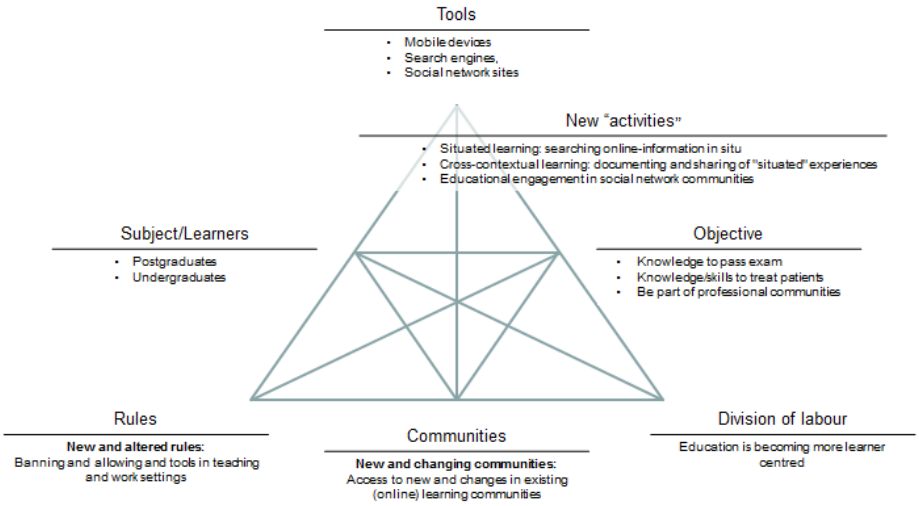

Abbildung 4 "Activity system" in Bezugnahme auf die Aneignung von ICT-Werkzeugen für medizinische Bildung in Entwicklungsländern (Pimmer et al., 2012b)

Aufbauend auf diesen Erkenntnissen wird in der Publikation 4 noch vertiefter auf die Bedeutung von sozialen Netzwerken im Internet in Kombination mit mobilen Kommunikationstechnologien eingegangen. Diese Medien nehmen sowohl im Alltag als auch in der medizinischen Kompetenzentwicklung der Zielgruppen, medizinischen Studierenden und Assistenzärzten, eine besondere Stellung ein. So greift eine Vielzahl der Forschungssubjekte mehrmals täglich auf das soziale Netzwerk "Facebook" zu. Die Plattform wird sogar als Anreiz für den Erwerb von internetfähigen Mobiltelefonen erachtet. In Beitrag 4 wird zusätzlich zu den Daten aus den Fokusgruppen eine Inhaltsanalyse der Facebook-Seite "Medical Profession, wow I love it" vorgenommen - eine Webseite, auf die einige der Befragten regelmässig zugreifen. Zum Zeitpunkt der

Untersuchung fanden darauf mehrere tausend Interaktionen pro Woche statt. Auf der Seite wurden breitgefächerte medizinische und klinische Themen durch Medizinstudierende und praktizierende Ärzte aus Ländern wie Nepal oder Indien diskutiert.

Bisherige Studien zur Lernrelevanz von sozialen Netzwerken im Internet haben primär aufgezeigt, dass darauf vielfach bildungs*nahe* Interaktionen, wie z.B. Diskussionen zur Organisation des Studiums oder die Vernetzung mit Mitstudierenden, stattfinden (Madge, Meek, Wellens & Hooley, 2009; Wodzicki, Schwämmlein & Moskaliuk, 2011). Im Kontrast dazu wurde in der vorliegenden Arbeit deutlich, dass auf der untersuchten Facebook-Seite, einer informellen Lernumgebung, explizite klassische Lerninhalte und Formen, wie z.B. Quizfragen oder Mini-Fallstudien, bereitgestellt und diskutiert wurden. Das sind Elemente, die eigentlich typisch für formelle Bildungskontexte wie die Lehre im Klassenzimmer oder auf einer strukturierten E-Learning-Plattform sind.

Neben der Identifikation dieser expliziten Lernformen kam bei der Analyse auch die sozio-kulturelle Lernrelevanz der untersuchten Seite zum Vorschein. In diesem Sinne wurden in Form von Beiträgen ("postings") die Wahrnehmung professioneller Identitäten zum Ausdruck gebracht (Zhao, Grasmuck & Martin, 2008) und das berufliche Selbstverständnis sowie der berufliche Status erörtert und verhandelt. So diskutierten "user" z.B. auf Basis von Cartoons oder Fragen wie "Proud to be in this profession, what about you?" welche Erwartungen, Pflichten, Normen oder Herausforderungen mit der Ausübung der ärztlichen Profession verbunden sind.

In Beitrag 7 werden die Bedeutung verschiedener technologischer Artefakte und damit verbundener externer Repräsentationen in einem Schweizer Spital erörtert. Dabei wird deutlich, dass die zentrale Rolle von Technologien für das Lernen keinesfalls auf ressourcenschwache Umgebungen beschränkt ist. Aufbauend auf der von Hutchins und Kollegen (2000; 1995, 2001; 1996) erarbeiteten "distributed cognition theory" (DCog), wird diskutiert, warum diese Themen zentral für klinische Kompetenzentwicklung sind. Klassische kognitive Theorien befassen sich mit der mentalen Verarbeitung und Repräsentation von Informationen (Mayer, 2010). Als Erweiterung dazu erachtet DCog eine (klinische) Umgebung, in der Wissen und Informationen in Form unterschiedlicher Repräsentation verteilt sind (und werden), als ganzheitliches kognitives System (Hutchins, 2001). Durch ein empirisches Beispiel - der Interaktion dreier medizinischer Akteure anlässlich einer Patientenbehandlung - wird gemäss den Prinzipien von DCog aufgezeigt, wie Kognition in Form von sozialen, körperlichen und artefaktbasierten Repräsentationen im weiteren klinischen System einer Notfallstation verteilt ist. Die im Fallbeispiel eingesetzten Medien (wie Röntgenbilder in einem klinischen Archivsystem, Lang- oder Kurzzeitgedächtnis der beteiligten Akteure, gesprochene Sprache oder Gesten) haben einen unterschiedlichen Angebotscharakter ("affordances") in Bezug auf die Dauerhaftigkeit und Verfügbarkeit in Raum und Zeit (Hutchins et al., 1996). Aus der Sicht von interaktionistischen und partizipativen Lernparadigmen wird diskutiert, wie Lernen und Kompetenzentwicklung durch multimodale Repräsentationen ermöglicht werden, die (1) eng miteinander verwoben sind, (2) gemeinsam konstruiert werden, (3) auf die wiederholt resp. redundant zugegriffen wird, (4) die intersubjektiv interpretiert werden und (5) über die Zeit hinweg im System erhalten bleiben ("substantiated").

Aufzeigen zukünftiger Forschungsrichtungen

Bei allen Beiträgen wurden auf Basis neuer Erkenntnisgewinne sowie methodischer und inhaltlicher Fokussierungen konkrete Vorschläge für weiterführende wissenschaftliche Forschungen erarbeitet.

Insbesondere Beitrag 7 zeigt zwei bisher wenig beleuchtete Aspekte klinischer Praxis und Kompetenzentwicklung auf, die zukünftig mehr analytische Beachtung finden sollten. Obwohl in der medizinischen Profession Wissen sehr stark körpergebunden ("embodied") ist (Kress, 2011) und klinische Arbeit durch intensive Technologie- und Werkzeugnutzung charakterisiert werden kann (Xiao, 2005), wurden diese beiden Themen in der medizinisch-klinischen Lernforschung bisher vernachlässigt. (Für vereinzelte Ausnahmen siehe Beiträge über "activity theory" oder über die Komplexitätstheorie Bleakley, 2010; Varpio, Hall, Lingard & Schryer, 2008).

So wird plädiert, dass zukünftige Forschungsarbeiten verstärkt analysieren sollen, wie klinische Akteure Gesten und Haptik (z.B. Positionen, Bewegungen oder Berührungen von Armen, Händen oder Oberkörpern) oder Blickwechsel in der klinischen Praxis nutzen, und welche Bedeutung diese für die Kompetenzentwicklung aufweisen. Zu diesem Themenfeld finden sich bisher nur vereinzelt Studien meist chirurgischer Provenienz. Erste Arbeiten zeigen z.B., wie Experten im Operationssaal Blicke, Sprache und Gesten miteinander verbinden, um Lernende zu instruieren (Heath, Luff & Sanchez Svensson, 2007); oder wie sie die Position und Bewegung ihrer Oberköper als Organisations- und Steuerungsinstrumente bei Operationen nutzen (Bezemer, Murtagh, Cope, Kress & Kneebone, 2011b). Während bisherige Studien verstärkt technologiegestütztes Lernen in formellen Lernkontexten erforscht haben Ausrichtung (Cook et al., 2008; Cook et al., 2010; Curran et al., 2005; Wutoh et al., 2004), propagiert Beitrag 7 die Bedeutung und den Angebotscharakter von alltäglichen, technologischen und elektronischen Artefakten (Kameras, Mobiltelefonen, Whiteboards, Computerterminals oder ganzheitliche Informationssysteme) zur näheren Bestimmung ihrer Lernrelevanz. Während vereinzelte Studien zu technologischen Artefakten vorliegen (siehe z.B. Bleakley, 2010) und die Bedeutung von neueren Technologien für den lernwirksamen Zugang zu digitalen Informationen betont wird (Robin, McNeil, Cook, Agarwal & Singhal, 2011), ist auch dieser Themenbereich insgesamt sehr wenig erforscht. Bei der angeregten zukünftigen Forschungsausrichtung sollen, analog einer Internetlandkarte (Evans, Guile & Harris, 2010), Mikro- und Makroperspektiven dynamisch kombiniert werden. Nur durch mikroperspektivische Momentaufnahmen können jene feingranularen Aspekte, die das Lernen in Kliniken konstituieren, identifiziert werden. Um diese höchst lernrelevanten Details zu verstehen, sind Observationstechniken wie teilnehmende Beobachtung und Videoanalyse notwendig (Bezemer, Cope, Kress & Kneebone, 2011a; Heath et al., 2007). Gleichzeitig muss im Sinne eines umfassenderen Verständnisses klinischer Kompetenzentwicklung berücksichtigt werden, wie die mikroperspektivischen Repräsentationen in einem klinischen System zeitlich, geographisch und sozial verteilt und dabei transformiert werden; und, wie z.B. Bezeemer (2011a) am Beispiel von interkultureller Zusammenarbeit im Operationssaal aufzeigt, wie diese mit allgemeineren organisatorischen und gesellschaftlichen Entwicklungen in Zusammenhang stehen.

Bei den Ausführungen und anhand des im Beitrag 7 skizzierten Beispiels wird deutlich, dass weder die technologischen Artefakte noch die körperlichen Praktiken isoliert betrachtet werden dürfen. Vielmehr bildet erst die umfassende Analyse der miteinander eng verwobenen, multimodalen Repräsentationen in weiteren organisatorischen und gesellschaftlichen Kontexten die Voraussetzung für ein umfänglicheres Verständnis klinischer Praxis und Kompetenzentwicklung. Mit der Arbeit wird einerseits intendiert, einen Beitrag zu den bisher dürftigen lern- und erziehungswissenschaftlichen Diskursen rund um DCog zu leisten. Hauptziel des Beitrags ist jedoch, auf Basis von DCog bisher wenig beachtete Themen in der medizinischen Bildungsforschung für zukünftige Forschungsarbeiten aufzuzeigen.

Bedeutung und Relevanz der Ergebnisse

Nebst den theoretischen Auseinandersetzungen weist die Dissertation viele praktische Bezüge auf und erlaubt Schlussfolgerungen hinsichtlich Gestalt und Gestaltung klinischer und medizinischer Kompetenzentwicklung auch für Kontexte jenseits der untersuchten Settings. So können zum Beispiel die erarbeiteten theoretischen Bezugsrahmen als Good-Practice- und Reflexions-Instrumente für Lernende, Lehrende und Mentoren dienen. Lernpraktiken und klinische Prozesse können – über den Kontext von Konsilien hinaus – auf Basis der Theorieentwürfe der Beiträge 1 und 6 verglichen werden. Ebenso lassen sich Stärken und Schwächen (z.B. in Form fehlender Lernprozesse) identifizieren. Der theoretische Bezugsrahmen des 5. Beitrags kann klinische Akteure darin unterstützen, die dynamischen Zusammenhänge verschiedener Wirkungsfaktoren und deren Einflüsse auf ihre Kompetenzentwicklung besser zu verstehen und dadurch Lernmöglichkeiten bewusster und gezielter zu nutzen. Der Theorieentwurf ist auch für das Management und für organisatorische Entscheidungsträger von Interesse, insofern er helfen kann, die Auswirkungen von gegenwärtigen, zumeist sehr stark effizienzorientierten Massnahmen bei Reorganisationsprojekten wie z.B. die Veränderung von Rollendefinitionen oder Prozessmodifikationen auf die gesamte "Wissensorganisation Spital" aufzuzeigen.

Von globaler bildungspolitischer Relevanz sind die Ergebnisse der Publikationen 3 und 4. Im Rahmen der "Millennium Development Goals", von denen drei (aus acht) Zielen direkt in den Bereichen Bildung und Gesundheit zu verorten sind, wird schlecht ausgebildetes Gesundheitspersonal als typischer Hemmschuh erachtet (Travis, Bennett, Haines, Pang, Bhutta, Hyder, Pielemeier, Mills & Evans, 2004). Digitalen Technologien, insbesondere den bereits mehr als 4.7 Milliarden Mobiltelefonen (The World Bank, 2011), wird ein wichtiges Potenzial für den besseren Zugang dieser Zielgruppe zu Bildung sowie zu evidenzbasierten Informationen attribuiert (Chandrasekhar & Ghosh, 2001). Viele der gegenwärtigen Diskurse und Vorhaben sind durch technozentrische Perspektiven geprägt. Charakteristischerweise werden dabei Technologie und Wissen von zentralen Stellen "top-down" verteilt; oder in den Worten von John Traxler: "information is pumped through the infrastructure often in educationally naïve ways" (2012). Ungeachtet zahlreicher Initiativen scheint der Fortschritt nicht zufriedenstellend und insbesondere bei der Versorgung von Gesundheitsakteuren in benachteiligten und abgelegenen Gebieten wurden wenige Verbesserungen erzielt. Es fehlt dabei vor allem an grundlegendem medizinischem Wissen (HIFA Report, 2010).

Vor diesem Hintergrund wird weitgehend übersehen, in welch kreativer und selbstbestimmter Form medizinische Akteure beginnen, sich mobile und soziale Medien für Lernzwecke anzueignen und sich miteinander zu vernetzen. So wird in den angeführten Beiträgen argumentiert, dass anstelle zusätzlicher technologiegetriebener Projekte Lernende vielmehr in ihren gegenwärtigen medialen Lernpraktiken unterstützt werden sollen. Eine wichtige Rolle nimmt dabei die Schulung von breitgefächerten Medienkompetenzen (Livingstone, 2004) von klinischen Lehrenden und vor allem Lernenden ein. Diese sollen den Zugang und die Analyse, aber auch die Evaluation und Gestaltung von medialen Botschaften umfassen. Dabei ist z.B. wichtig, dass Studierende einen kritischen Umgang in Bezug auf die Glaubwürdigkeit von Informationen aus sozialen Netzwerken und dem Internet allgemein erlernen, oder dass sie neue Informations- und Lernressourcen zielorientiert nützen. Dabei sollen Studierende insbesondere für das grosse Ablenkungspotenzial sozialer Medien sensibilisiert werden. Diese Problematiken sind mitnichten auf den Untersuchungskontext beschränkt (Bugeja, 2006). Keineswegs sollen diese neuen technologiegestützten Lernaktivitäten von

Bildungsverantwortlichen ignoriert oder gänzlich verboten werden - eine Tendenz, die jedoch in den Untersuchungskontexten zu beobachten war. Eine weitere wichtige Frage, die in diesem Zusammenhang zu lösen ist, betrifft die Integration und die Anerkennung von Lernen in informellen Kontexten in der formalen (medizinischen) Bildung (Pachler et al., 2010b). Daneben werden in den Beiträgen 3 und 4 ethische Aspekte identifiziert, die von den medizinischen Akteuren berücksichtigt werden müssen, wenn sie klinische Erfahrungen mit Kolleginnen und Kollegen auf kommerziell orientierten, sozialen Netzwerkseiten diskutieren. Auch diese Problematiken sind nicht auf die untersuchten Entwicklungskontexte beschränkt (MacDonald, Sohn & Ellis, 2010; Wishart, 2009). Besondere Aufmerksamkeit muss der Aufnahme von klinischen Bildern oder Videos mit Mobilgeräten geschenkt werden, die als eine nicht-therapeutische Funktion keinen direkten Beitrag zur Patientengesundung leistet (Berle, 2008). Hier sollten die Studierenden auch bei nicht-identifizierbaren Bildern oder Videos angewiesen werden, explizites Einverständnis der Patientenseite einzuholen (Bhangoo, Maconochie, Batrick & Henry, 2005). Die skizzierten Aufgaben dürfen nicht einzelnen Lehrkräften oder Mentoren überlassen werden, sondern müssen integrativer Bestandteil medizinischer Aus- und Weiterbildungscurricula werden. Angesichts der weiten Verbreitung von Phänomenen wie der Aufnahme digitaler klinischer Bilder, wäre, wie Berle (2008) fordert, eine Integration von Verhaltensregeln in medizinische Verhaltenskodizes wünschenswert.

Die Erkenntnisse riefen im internationalen Kontext grosses Interesse hervor. Sie wurden einerseits auf wissenschaftlichen Tagungen, wie z.B. am *International Roundtable: Social Mobile Networking for Informal Learning (Universität London)* oder an der *UCL Medical Education Conference* (London), vorgestellt. Der Autor wurde zudem eingeladen, die Arbeiten vor politischen und wirtschaftlichen Entscheidungsträgern, NGOs und internationalen Organisationen, wie z.B. WHO, UNESCO, ITU, USAID am *World Summit on the Information Society* (Genf) und bei dem *United Nations-Gipfel GEThealth* in New York vorzustellen - mit dem Ziel, die Erkenntnisse in globale, nationale und regionale Strategie- und Technologieentwicklungsprozesse einfliessen zu lassen.

Grundzüge und Charakteristika

Im Folgenden werden Forschungsansätze und Charakteristika beschrieben, die den vorliegenden Arbeiten zugrunde liegen.

Epistemologische Ausrichtung

Die vorgelegten Arbeiten basieren, wie insbesondere in Publikation 7 deutlich wird, auf einem partizipatorischen und interaktionistischen epistemologischen Grundverständnis von Lernen. Das heisst, Lernen wird einerseits als eine – zunehmend zentrale – Partizipation eines Individuums in einer "community of practice" verstanden (Lave & Wenger, 1991). Dies erscheint insofern von grosser Bedeutung, als sich klinische Systeme dadurch kennzeichnen, dass sie kontinuierlich erfahrenes medizinisches Personal abgeben und neue, wenig erfahrene Mitarbeitende aufnehmen. Zudem wird Lernen nicht nur als Ergebnis von Lehr- und Lernprozessen erachtet. In einer interaktionistischen Sichtweise sind ebendiese Interaktionen auch als konstitutives Element von Lernen zu verstehen (Suthers, 2006). In den Worten von Koschmann bedeutet das die Analyse von "how participants actually go about doing learning" (2005). Diese Sichtweise wird, z.B. in den theoretischen Bezugsrahmen der Publikationen 1 und 6, deutlich. Die angeführten sozio-kognitiven Prozesse resultieren nicht in (mentalen) Lernvorgängen, sondern konstituieren bereits Lernen in der Form von "interactional achievement" (Koschmann et al., 2005).

Explorative und ergebnisoffene Ansätze

Es gibt verschiedene grundlegende Forschungsansätze, die sich, historisch gesehen, als Ansätze des "Explorierens", des "Beschreibens" und des "Erklärens" eines Phänomens zusammenfassen lassen (Marshall & Rossman, 1999). Das explorative Paradigma impliziert die Generierung von reichhaltigen Beschreibungen komplexer, wenig erforschter Phänomene, die Identifikation wichtiger Bedeutungskategorien und Zusammenhänge sowie die Erarbeitung von Thesen für weiterführende Forschungsarbeiten. Die Exploration ist keine "Vorform" von Forschung, sondern stellt gerade in sich rasch ändernden Zeiten einen vollwertigen und attraktiven Ansatz der Sozialforschung dar. Um ein Phänomen zu explorieren, ist es wichtig, zuerst eine breite und nicht zu spezialisierte Perspektive einzunehmen: "first observe the woods, then study its individual trees" (Stebbins, 2001). Die theoriegeleitete Strukturierung des Forschungsgegenstandes durch den Forschenden soll (anfangs) zugunsten der Strukturierung in Bezug auf Bedeutung und Relevanz durch die Forschungssubjekte zurückgestellt werden (Lamnek, 2005). Entsprechend offen wurden zu Beginn der jeweiligen Untersuchungen auch die Leitfragen formuliert und die Gespräche durchgeführt. Der Untersuchungsgegenstand bestimmte weitgehend das Forschungsvorgehen; hochstrukturierte und standardisierte Ansätze wurden nicht angewendet (Atteslander, Cromm, Grabow, Klein, Maurer & Siegert, 2003; Lamnek, 2005). Der flexible und ergebnisoffene Ansatz liess, so z.B. bei den Arbeiten 3 und 4, genug Spielraum für die Exploration unerwarteter Phänomene (wie die intensive Nutzung privater Mobiltechnologien und sozialer Netzwerke für Bildungszwecke).

Der Ansatz der "grounded-theory" (Glaser & Strauss, 1967) verlangt von den Forschenden, die Datensammlung und -Interpretation völlig unabhängig von bestehenden Konzepten und Theorien durchzuführen und sich nicht von den Ergebnissen vorheriger Forschungsaktivitäten leiten zu lassen. Diese Position stiess auf Kritik in der Wissenschaftsgemeinde. So wurde moniert, dass es für Forschende grundsätzlich unmöglich sei, sich von (Vor-)Wissen, existierenden Bedeutungsmustern, Begrifflichkeiten, Werten oder Vorurteilen loszusagen und gänzlich neutral an die Forschung heranzugehen. Bereits die Auswahl eines Forschungsthemas stelle einen subjektiven Vorgang dar. Dies, so wird argumentiert, wäre jedoch kein Hindernis, das es zu eliminieren gälte, sondern solle als fester und lohnenswerter Aspekt qualitativer Sozialforschung begriffen werden:

> "The problem is that a priori assumptions are uneliminable, and this fact – far from being a source of anguish – is what the qualitative researcher should expect: a priori assumptions are what make study a) worthwhile, and b) possible." (Thomas & James, 2006).

Wichtig ist die Bewusstmachung und Offenlegung von Sichtweisen, die dem Forschungsvorhaben wie den Forschenden zugrunde liegen. Auch vor diesem Hintergrund wurden die Arbeiten epistemologisch oder theoretisch verortet und grundlegende Perspektiven - wie z.B. im Beitrag 6 die sozio-kognitiven, situierten und informellen Ansätze - explizit angeführt.

Interdisziplinarität

Die vorliegenden Arbeiten lassen sich in verschiedener Hinsicht durch ein hohes Mass an Interdisziplinarität charakterisieren: Erstens lässt sich der Untersuchungsgegenstand an der Schnittstelle verschiedener Forschungsdisziplinen, wie z.B. der medizinischen Bildung, des technologiegestützten Lernens oder des arbeitsbasierten Lernens verorten. Entsprechend bedienen sich die Arbeiten aus dem vielfältigen konzeptionellen und theoretischen Repertoire dieser Gebiete. Zweitens ist Interdisziplinarität auch Gegenstand der Forschung selbst, indem mit den Konsilien ein

sehr typisches Beispiel interdisziplinärer Zusammenarbeit in Spitälern untersucht wurde. Die bis dato vorliegende Literatur beleuchtet in erster Linie die Frage, wie Gesundheitspersonal bestmöglich auf interdisziplinäre Teamarbeit vorbereitet werden kann (Carpenter, 1995; Lavin, Ruebling, Banks, Block, Counte, Furman, Miller, Reese, Viehmann & Holt, 2001; Sternas, O'Hare, Lehman & Milligan, 1999). Die Ergebnisse der Dissertation erweitern diese Sichtweise, indem sie aufzeigen, wie medizinische Akteure nicht nur für, sondern auch durch interdisziplinäre Zusammenarbeit lernen.

Drittens wurden die Forschungsergebnisse in interdisziplinären Teams mit Autoren aus unterschiedlichen medizinischen und sozialwissenschaftlichen Fachrichtungen erarbeitet. Dabei wurden linguistische, psychologische, pädagogische und diverse medizinische Fachrichtungen integriert. Obwohl die Involvierung von mehreren Forschenden in den Interpretationsprozess nicht unumstritten ist, werden dieser Technik in Bezug auf Konsistenz positive Effekte attribuiert. Insbesondere die Zusammenarbeit von Sozialwissenschaftlern und Klinikern wird als positiv erachtet, weil diese fachbezogenen Verzerrungen vorbeugen kann (Pope, Ziebland & Mays, 2000). In der medizinischen Bildungsforschung wird zudem die Bedeutung der gleichzeitigen Involvierung von "Insidern" und "Outsidern" hervorgehoben; eine Konstellation, die auch im Rahmen der vorliegenden Arbeiten zum Einsatz kam: An den Forschungen wirkten sowohl Ärzte aus den jeweiligen Untersuchungskontexten als auch externe Forschende mit. Während Erstere in der Lage waren, widersprüchliche Aussagen im politischen und historischen Kontext zu erklären, ermöglichte die externe Perspektive das Hinterfragen von scheinbar gegebenen sozialen Phänomenen (Smith, Morris, Francovich, Hill & Gieselman, 2004).

Forschungsschritte und Elemente

Bei qualitativer Sozialforschung gibt es keinen "Königsweg", sondern eine Vielzahl an unterschiedlichen Varianten, die im jeweiligen Forschungskontext entsprechend ausgewählt und begründet werden müssen. In den Arbeiten wurde die qualitative Forschung in folgender Form und (iterativer) Sequenz realisiert: Nach der Datensammlung im Feld folgte unmittelbar und zum Teil parallel verlaufend die Analyse und Interpretation des Materials. Dabei wurde versucht, bereits unmittelbar im Anschluss an eine Erhebungseinheit, z.B. eine teilnehmende Beobachtung im Spital, erste Muster, Kategorien, Konzepte oder breite Themen sowie deren Zusammenhänge in den Daten durch Zusammenfassungen und schriftliche Reflexionen festzuhalten. Das zeigt die enge Verflechtung von Erhebung, Interpretation und Theorieentwicklung – ganz im Sinne qualitativer Forschung. Beispielsweise betont Anselm Strauss, der Mitbegründer der "grounded theory" (Corbin & Strauss, 1990), die Bedeutung der beinahe gleichzeitigen Durchführung von Erhebung und Auswertung: Es wäre wichtig, "schon nach dem ersten Interview mit der Auswertung zu beginnen, Memos zu schreiben und Hypothesen zu formulieren, die dann die Auswahl der nächsten Interviewpartner nahelegen." (Interview in Legewie & Schervier-Legewie, 2004). In den nächsten Absätzen werden die verschiedenen Phasen und Elemente kurz charakterisiert.

Sampling

Noch vor dem Beginn der Datensammlung musste die Selektion der Teilnehmenden, das "Sampling", vorgenommen resp. Selektionsstrategien festgelegt werden. Bei den vorliegenden Arbeiten erfolgte das Sampling nicht rein zufällig (wie z.B. bei experimenteller Forschung üblich), sondern zielgerichtet und zweckgebunden ("purposeful sampling"). Dabei ging es weniger um statistische Repräsentativität, sondern um das "Typische" und um die Frage, inwieweit durch die zu untersuchenden Subjekte neue Erkenntnisse gewonnen werden können. (Lamnek, 2005; Patton, 1990). Entsprechend erfolgte in den

vorliegenden Arbeiten die Involvierung der zu Befragenden auf Basis des "typical case sampling" und des "random probability sampling". Bei der Erforschung von Konsilien wurden mit dem Fokus auf Notfallkonsilien typische und häufige Fälle interdisziplinärer Zusammenarbeit ausgewählt. Dabei wurden die Forschungssubjekte aufgrund ihrer Repräsentativität in Bezug auf eine Population resp. einer typischen Rolle zufällig selektioniert (Mays & Pope, 2000). So wurde z.B. bei der Auswahl der zu Befragenden auf eine ausgewogene Mischung sowohl von Rollen (Assistenzärzte und Oberärzte) als auch verschiedenen Spitaltypen (Zentrumsspitäler und Regionalspitäler) Wert gelegt. Bei den Erhebungen im Entwicklungskontext wurden Medizinstudierende, Assistenzärzte, Lehr- und Fakultätspersonal bis hin zum Management aus je einem privaten und einem öffentlichen Spital eingebunden.

Datensammlung

Die Instrumente der Datensammlung umfassten mit semistrukturierten Einzelinterviews, Fokusgruppen, Inhalts-/Dokumentanalysen, teilnehmender Beobachtung und "shadowing" ein sehr breites Spektrum qualitativer Erhebungsmethoden (Barbour, 2005; Giacomini & Cook, 2000a; Lamnek, 2005; McDonald, 2005). In den Interviews und den Fokusgruppen kamen semi-strukturierte Befragungsverfahren zum Einsatz; d.h., die Gespräche orientierten sich an einer Liste offener Fragen (resp. eines Leitfadens). Diese Art der Gesprächssteuerung wurde dem noch weniger strukturierten, nicht-direktiven Tiefeninterview, das die Kontrolle weitgehend zu den Forschungssubjekten verlagert (Emerald - Research Zone), vorgezogen. Der Fokus der Arbeit ist einerseits auf bestimmte Facetten gerichtet, wie den Konsilprozess oder die Technologienutzung, und erlaubte aufgrund der definierten Leitfragen ein gezielteres Vorgehen als bei sehr offenen Forschungsthemen (wie z.B. bei der Frage nach der Kompetenzentwicklung im klinischen Kontext allgemein); andererseits erforderte das begrenzte Zeitpensum insbesondere bei den ärztlichen Interviewpartnern aus forschungspragmatischer Sicht eine gewisse Steuerung des Interviewprozesses. Die semi-strukturierten Fragen wurden bei den Gesprächen in Form und Reihenfolge – abhängig von der Reaktion der zu Interviewenden – variiert. Zudem wurde explizit Freiraum für Themen und Aspekte gelassen, die die Teilnehmenden neu in die Gespräche einbrachten (Patton, 1990). Insbesondere in der Anfangsphase einer Serie wurden die Fragen gemäss der Erkenntnisse aus den ersten Gesprächen angepasst.

Im untersuchten Entwicklungskontext wurden Fokusgruppen ausgewählt, weil sich diese sehr gut dazu eignen, Veränderungen zu erfassen (Barbour, 2005) und dadurch der Fragestellung nach der Transformation von "activity systems" in Artikel 3 gerecht wurden. In einer weiteren Fokussierung, und im Sinne des explorativen und offenen Forschungsansatzes, wurde schliesslich eine Inhaltsanalyse einer Webseite vorgenommen. Dazu wurden alle Beiträge der Facebook-Seite "Medical Profession, wow I love it" in einem bestimmten Zeitraum heruntergeladen, analysiert und wichtige Themen im Rahmen einer qualitativen Inhaltsanalyse (siehe Abschnitt Inhaltsanalyse) identifiziert.

Während der Feldstudie in einem Schweizer Spital kamen Verfahren der direkten teilnehmenden Beobachtung zum Einsatz (Giacomini et al., 2000a; Patton, 1990), die mit der direkten Begleitung einzelner Ärzte, dem sogenannten "shadowing" (McDonald, 2005), und kurzen informellen Interviews kombiniert wurden. Die Beobachtungen waren bedeutsam, weil sie die sozialen Lernprozesse und körperlichen Praktiken in den Beiträgen 6 und 7 zu identifizieren halfen. Die informellen Gespräche im Anschluss an einzelne Beobachtungssequenzen erwiesen sich für den Autor als essentiell, um komplexe, fachfremde Praktiken besser nachvollziehen und einordnen zu können:

> "What the observer ‘sees’ may need insider input for sophisticated interpretation" (Lingard, 2008)

Während der Beobachtungen wurden Notizen und Beobachtungsprotokolle angefertigt, die nach jeder Observation in den Computer, d.h. in die Analysesoftware Nvivo (Lewins & Silver, 2009), übertragen wurden.

Inhaltsanalyse

Die Daten wurden im Rahmen einer qualitativen Inhaltsanalyse ausgewertet. Die Inhaltsanalyse wurde Anfang des letzten Jahrhunderts im Bereich der Kommunikationswissenschaften in den USA entwickelt, um grosse Textmengen der zunehmenden Massenmedien oder Propagandamaterial besser untersuchen zu können (Rosenthal, 2005). Die Ansätze sozialwissenschaftlicher Textanalyse stammen aus den Gebieten der Geistes- und Kulturwissenschaften, den Literatur- und Sprachwissenschaften sowie den Kommunikationswissenschaften. Angesichts der Einschränkungen der anfangs rein quantitativ ausgerichteten textanalytischen Verfahren, wurden verschiedene qualitative Ansätze entwickelt. Beispiele dafür sind die ethnografische resp. qualitative Inhaltsanalyse nach Altheide (1996), die "Protocol Analysis" zur Untersuchung kognitiver Prozesse bei Problemlöseverfahren (Ericsson & Simon, 1993) oder qualitative inhaltsanalytische Verfahren zur Untersuchung von asynchroner Online-Kommunikation (Anderson & Kanuka, 2003; Garrison & Anderson, 2003). Heute ist die qualitative Inhaltsanalyse eine der gängigsten methodischen Ansätze qualitativer sozialwissenschaftlicher Forschung. Einer der wichtigsten Vertreter ist Philipp Mayring, der, in späteren Arbeiten, den Begriff der "qualitativ-orientierten" Textanalyse bevorzugt (Mayring, 2010a). Er sieht darin ein systematisches, regelgeleitetes Vorgehen, das er in vielen weiteren Ansätzen qualitativer Sozialforschung, wie z.B. der Hermeneutik oder der Ethnomethodologie, vermisst (Mayring, 1985). Auf der anderen Seite versucht Mayring durch die qualitative Vorgehensweise Schwächen quantitativer inhaltsanalytischer Verfahren auszugleichen. So beschränkt sich sein Ansatz nicht auf die reine Analyse formaler Textbestandteile, sondern ermöglicht die Untersuchung tiefgründiger Bedeutungsstrukturen.

Induktive und deduktive Analysetechniken

Mayring unterscheidet bei der qualitativen Inhaltsanalyse unter anderem induktive und deduktive Techniken. In der vorliegenden Arbeit lehnen sich die Beiträge 4, 5 und 6 am systematischen und regelbasierten, induktiven Kategorienbildungsverfahren nach Mayring an (2004, 2008). Am Anfang des Prozesses der induktiven Kategorienbildung standen keine detaillierten Hypothesen, sondern der Gegenstand oder Fragestellungen, die durch wiederholte Interpretation des Datenmaterials geschärft wurden. Das Abstraktionsniveau wurde festgelegt und die Kategorien durch Definitionen charakterisiert. Die schrittweise Bildung und iterative Überarbeitung der Kategorien erfolgte anhand der wiederholten Analyse von ca. 10-50% des Datenmaterials. Beim Lesen und Interpretieren des Materials wurden jene Aspekte berücksichtigt, die den definierten Kategorien entsprachen. Mayring benützt dafür die Metapher eines "Rechens", an dessen Zacken das jeweils relevante Material haften bleibt (Mayring, 2010b).

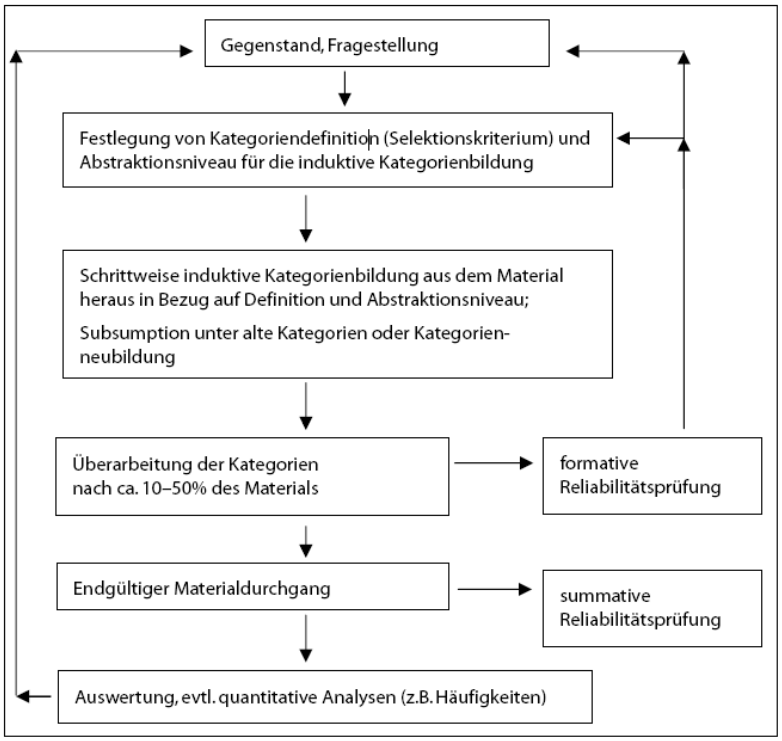

Abbildung 5 Prozess induktiver Kategorienbildung (Mayring, 2008)

Angesichts des explorativen Charakters des Forschungsvorhabens wäre eine anfänglich zu starke Systematisierung in Form einer sehr spezifischen Fragestellung, einer rigiden Definition oder der Bestimmung von Kodierregeln und Selektionskriterien zu einengend und einschränkend gewesen. So gilt Mayrings induktive Kategorienbildung auch als "keineswegs so offen, wie dies zunächst klingen mag" (Rosenthal, 2005), insofern ihr sehr konkrete Ausgangsfragestellungen zugrunde liegen. Die Kategorienbildung würde dabei zu stark vorbestimmt und würde sich nicht ausreichend am Material orientieren (Rosenthal, 2005). Aus diesem Grund wurde insbesondere bis zur finalen Überarbeitung der Kategorien (Schritt 4 aus Abbildung 5) der Forschungsprozess entsprechend offen und induktiv gestaltet. Diese Vorgehensweise soll auch dazu dienen, dem Vorwurf der Subsumtionslogik entgegenzuwirken - eines gehaltskonservierenden Ansatzes (Seipel & Rieker, 2003), mit dem Mayring konfrontiert wird (Mayring, 2010a). Die "strenge" systematische Analyse kam vor allem beim "endgültigen Materialdurchgang" (Schritt 5, Abbildung 5) zum Tragen.

Im Gegensatz dazu orientieren sich die Verfahren in den Beiträgen 3 und 7 an der "deduktiven Kategorienanwendung" nach Mayring (2000). Während der Datenerhebungsprozess offen gestaltet war, wurden die Kategorien vor Beginn des Analyseverfahrens aus bestehenden Theorien, z.B. der "activitiy theory" (Engeström, 1987, 2001) oder der "distributed cognition theory" (Hollan et al., 2000; Hutchins, 2001; Hutchins et al., 1996), abgeleitet. Durch die starke theoretische und konzeptionelle Ausrichtung des Beitrags 7 wurden nur selektiv Sequenzen aus der teilnehmenden Beobachtung gewählt, um die Bedeutung der "distributed cognition theory" im klinischen Lernkontext aufzuzeigen.

Publikation 1 kombinierte induktive und deduktive Techniken: Dabei wurde die Forschungsfrage nach den persönlichen Einschätzungen und der Lernrelevanz von Konsilien induktiv adressiert; zur Beantwortung der zweiten Forschungsfrage wurden die instruktionalen Methoden des "cognitive

apprenticeship" deduktiv als Analyseeinheiten herangezogen. Allerdings wurde auf Basis dieses deduktiven Verfahrens wiederum induktiv ein neuer Bezugsrahmen (siehe Abbildung 1) erarbeitet.

Computergestützte qualitative Datenanalyse

In der qualitativen Sozialforschung sind computergestützte Programme zur Datenanalyse weit verbreitet. Die softwarebasierte Datenauswertung wird als "computergestützte qualitative Datenanalyse" ("computer assisted qualitative data analysis") bezeichnet (Gibbs, Friese & Mangabeira, 2002). Die Nutzung von Software kann die Datenanalyse erleichtern, jedoch in keiner Weise die kritische und kreative Auseinandersetzung des Forschenden mit dem Datenmaterial ersetzen (Giacomini et al., 2000a; Gibbs et al., 2002).

In der vorliegenden Arbeit wurde die Software "Nvivo" verwendet. Bei den Forschungsarbeiten wurden die Audiodateien aus den Interviews und Fokusgruppen wortwörtlich transkribiert, die Ergebnisse der teilnehmenden Beobachtung schriftlich dokumentiert und auch die Inhalte der untersuchten Webseite in Textdateien kopiert. Die Texte wurden in Nvivo importiert und dort analysiert. Die Software unterstützte die Textanalyse, indem Textausschnitte markiert, annotiert, durchsucht und einer oder mehreren Kategorien (in der Notation von Nvivo "Knoten") zugeordnet werden konnten. Unter einem Knoten wurden Texteinheiten aus verschiedenen Datenquellen, die identische oder ähnliche Ideen oder Themen zum Ausdruck brachten, neu gespeichert, d.h. "kodiert" (Bandara, 2006). Dadurch war es zum Beispiel möglich, Textausschnitte aus Interviews, Beobachtungsprotokollen oder anderen Dokumenten in ein neues Dokument (einem Knoten) zu integrieren. Auf diese Weise konnten unterschiedliche Perspektiven von verschiedenen Forschungssubjekten und aus verschiedenen Erhebungsperspektiven in einem Gefäss zusammengetragen, verglichen und weiter analysiert werden (Bourdon, 2002).

Qualitative Sozialforschung erhebt den Anspruch, intersubjektiv nachvollziehbar zu sein (Atteslander et al., 2003). Das heisst, es soll grundsätzlich möglich sein, nachzuvollziehen, wie die Forschenden zu den Erkenntnissen gelangt sind (Giacomini et al., 2000a). Qualitative Analysesoftware ermöglicht die Nachvollziehbarkeit von Interpretationsschritten, indem diese dokumentiert und dadurch repliziert werden können. Ebenso wurden mit Nvivo Interpretationsdifferenzen zweier Forschender im Rahmen der Interkoderreliabilitätsprüfung berechnet, visualisiert und konsensorientiert diskutiert (vgl. Abschnitt Interkoderreliabilität).

Ergebnisformen: Theorie-Entwicklungen

Die Ergebnistypen von sozialwissenschaftlicher Forschung enthalten typischerweise keine eindeutigen "Ja/Nein-Antworten", sondern werden in verschiedenen Formen, wie z.B. Narrationen, Konzepte, Bezugsrahmen, Modellen oder Metaphern dargestellt (Giacomini & Cook, 2000b) und anhand von empirischen Auszügen aus Interviews, Feldnotizen oder Dokumenten exemplifiziert. Die Ergebnistypen können von der Art der Forschung abhängen und je nach Disziplin unterschiedlich ausgeprägt sein: Beispielsweise beinhalten ethnografische oder naturalistische Studien tendenziell reichhaltige Beschreibungen und weniger deutlich ausgeprägte Konzepte, ohne dass ihr wissenschaftlicher Wert dadurch geringer wäre. (Giacomini et al., 2000b).

Übergeordnetes Ziel der vorliegenden Forschungsarbeiten – wie von empirischer Sozialforschung allgemein – ist die Generierung neuerer, "besserer" Theorien. Unter einer sozialwissenschaftlichen Theorie wird – allgemein gesprochen – ein "System logisch widerspruchsfreier Aussagen über soziale

Phänomene verstanden". (Atteslander et al., 2003). Der Theoriebegriff wird in der Literatur sehr unterschiedlich gehandhabt. Sozialwissenschaftliche Theorien müssen nicht notwendigerweise jene Merkmale aufweisen, die für eine naturwissenschaftliche Theorie im Sinne eines gut strukturierten, modellartigen und quantitativ untermauerten Hypothesengebildes typisch sind. Es wird bereits von einer Theorie gesprochen, wenn diese "eher den Charakter einer Skizze aufweist und in erster Linie aus einem Begriffsapparat besteht". (Kirsch, Seidl & Aaken, 2007). Dies begründet sich durch den oftmals explorativen Forschungscharakter und der – z.B. im Vergleich zur physikalischen Forschung – "chronischen Unreife" (Kirsch et al., 2007) sozialwissenschaftlicher Theorien. In diesem Lichte schlagen Kirsch, Seidl und van Aaken vor, unter einem theoretischen Bezugsrahmen einen Theorieentwurf zu verstehen; Begrifflichkeiten, die auch im vorliegenden Dokument verwendet werden. Bezugsrahmen weisen unterschiedliche Ausprägungsformen auf und können von skizzenartigen Konzeptionen bis hin zu reiferen und detaillierten Ansätzen mit grundlegenden Hypothesen reichen. Sowohl rudimentäre Theorieentwürfe als auch theoretische quantitative Modelle bedienen sich eines zugrunde liegenden Begriffsapparats resp. einer spezifischen Sprache, die als "generatives Sprachspiel" bezeichnet wird. (Kirsch et al., 2007).

Alle Beiträge weisen auf unterschiedliche Art und Weise eine ausgeprägte theoretische Orientierung auf. In der Publikation 2 erfolgt die Aufbereitung und kritische Diskussion wichtiger konzeptioneller und theoretischer Grundlagen, z.B. der Theorie des situierten Lernens (Lave et al., 1991), der "activity-theory" (Engeström, 1987, 2001), oder kulturellen-ökologischen Lerntheorien (Pachler et al., 2010a; Pachler et al., 2010b); Das sind Konzepte und Theorien, worauf die weiteren empirischen Arbeiten Bezug nehmen. In den Beiträgen 1, 3 und 7 werden empirische Daten mit Theorien in Bezug gesetzt, kritisch reflektiert und bestehende Theorien auf dieser Basis kritisch diskutiert resp., wie in Beitrag 1 und 7, weiterentwickelt. In den Beiträgen 4, 5 und 6 wurden Theorieentwürfe resp. theoretische Bezugsrahmen durch Inhaltsanalyse induktiv aus dem Datenmaterial entwickelt. Die erarbeiteten Theorieentwürfe können, im Vergleich zu mathematischen Modellen, keine quantitativen Kausalzusammenhänge im engeren Sinne aufzeigen; sie ermöglichen "Erklärungsskizzen, die zu einem Verständnis von Zusammenhängen führen" (Kirsch et al., 2007). Zusammenfassend wurde in den Arbeiten auf eine Vielzahl an allgemeinen Lerntheorien aus sozio-kulturellen, sozio-kognitiven, situierten und informellen Lernperspektiven als auch auf eine Anzahl an spezifischen klinischen Kompetenzentwicklungsmodellen aus dem Bereich der medizinischen Bildung Bezug genommen.

Validierungsmethoden

In der quantitativen Sozialforschung beschreibt die Gültigkeit oder Validität, inwieweit eine Methode das Merkmal erfasst, das sie zu erfassen beansprucht (Lamnek, 2005). Das Konzept der Validität wird auch in der qualitativen Sozialforschung als zentrales Gütekriterium akzeptiert; es hat dabei jedoch eine andere "Qualität". Validierung wird als Prozess mit interpretativ-kommunikativem Charakter zwecks Bildung von Vertrauenswürdigkeit, Glaubwürdigkeit, Verlässlichkeit und "Bestätigbarkeit" verstanden (und weniger als ein messtechnisches Ergebnis). In den Arbeiten kamen die im Folgenden beschrieben Methoden zur Validierung der Forschungsergebnisse zum Einsatz: Triangulation, kommunikative Validierung und Interkoderreliabilität (Lamnek, 2005).

Triangulation

Ein weithin verbreitetes, jedoch nicht unumstrittenes Gütekriterium qualitativer Forschung ist die Triangulation, der Einsatz unterschiedlicher Ansätze und Perspektiven in Bezug auf einen

Untersuchungsgegenstand. Der Triangulationsbegriff wurde von Denzin (1978) aufgenommen und ausgearbeitet. Er unterscheidet in seinem Ansatz insgesamt vier verschiedene Formen, die in den Arbeiten entsprechend eingesetzt wurden: die Triangulation der Daten, der Forschenden, der Theorien und der Methoden (vgl. Lamnek, 2005). Der Begriff der Datentriangulation beschreibt die Sammlung von Daten an unterschiedlichen Orten und die Involvierung von verschiedenen Forschungssubjekten (Decrop, 1999; Mays et al., 2000). Datentriangulation wurde angewendet, indem jeweils mehrere Forschungssubjekte aus unterschiedlichen Gruppen (Medizinstudierende, Assistenz- und Oberärzte) an verschiedenen Orten (z.B. zwei grosse Zentrumsspitäler) in die Samplingstrategien eingebunden wurden (Decrop, 1999). Im Sinne der Forschendentriangulation wurden, z.B. in den Beiträgen 3 und 4, zwei Forschende in den Datenerhebungsprozess involviert. In vielen Studien, wie auch in den vorliegenden Arbeiten, wird die Forschendentriangulation in der Interpretations- resp. Datenauswertungsphase angewendet (vgl. z.B. Decrop, 1999; Giacomini et al., 2000a). Wie bereits im Abschnitt zur Interdisziplinarität deutlich wurde, stellt insbesondere die Involvierung von Forschenden aus unterschiedlichen Disziplinen sowie "In"- und "Outsidern" der Untersuchungskontexte einen Mehrwert dar. Die Theorientriangulation beschreibt die Analyse eines Phänomens anhand verschiedener theoretischer Annahmen. So wurden, beispielsweise in Beitrag 6, theoretische Perspektiven des informellen und des situierten Lernens kombiniert und als Reflexionsgrundlage für die Analyse des empirischen Materials verwendet. In Beitrag 5 wurde die Interpretation des erarbeiteten theoretischen Bezugsrahmens auf Basis bestehender medizinisch-klinischer Theorieentwürfe, wie z.B. von Dornan et al., (2007) oder Boor et al., (2008), durchgeführt. Die Methodentriangulation umfasst die Nutzung verschiedener Datensammlungsmethoden (Decrop, 1999; Mays et al., 2000). Die Aussage, durch den Einsatz mehrerer Methoden sowie durch die Nutzung verschiedener Datenquellen eine höhere Validität zu erzielen, ist in der Literatur allerdings umstritten: Es wird argumentiert, dass dadurch möglicherweise nicht unterschiedliche Aspekte desselben Phänomens, sondern unterschiedliche Phänomene beleuchten werden. Zudem würde die Methodentriangulation einen positivistischen, kontextfreien Methodenbegriff implizieren. Durch blinde Addition verschiedener Methoden und der Nichtberücksichtigung ihrer handlungstheoretischen Eignung wäre keine höhere Validität zu erzielen. (Lamnek, 2005). Triangulation könne somit nicht die Validität, sondern die "Tiefe" und "Weite" und somit die Umfänglichkeit und Reflexivität von Forschungsergebnissen erhöhen (Lamnek, 2005; Mays et al., 2000). Indem, z.B. in Beitrag 4, jene in den Fokusgruppen erhobenen Themen mit einer Inhaltsanalyse einer Website kontrastiert, oder in den Beiträgen 5 und 6 Ergebnisse aus den Interviews mit Daten der teilnehmenden Beobachtung verglichen wurden, konnten in der Tat Teilbereiche desselben Phänomens aus verschiedenen Perspektiven beleuchtet und entsprechend validiert werden. Ebenso traten dabei neue Phänomene oder neue Aspekte des untersuchten Phänomens zum Vorschein. So erlaubte die teilnehmende Beobachtung vertiefte Einblicke in die sozialen Interaktionen und körperlichen Praktiken der beteiligten Akteure; und die Facebook-Analyse führte zu zusätzlichen Erkenntnissen vor allem aus sozio-kulturellen Lernperspektiven.

Kommunikative Validierung

Indem vorläufige Erkenntnisse an die Forschungssubjekte zurückgegeben und deren erneute Rückmeldungen wiederum in die Forschungsresultate eingearbeitet wurden, bediente sich der Autor der Technik der kommunikativen Validierung ("respondent validation" oder auch "member checking" genannt, vgl. dazu Mays et al., 2000). So wurden die vorläufigen Ergebnisse der Fokusgruppen und der Interviews in Form schriftlicher Zusammenfassungen an die Forschungssubjekte zurückgespielt

und um kritisches Feedback gebeten. In der Literatur wird betont, dass potenzielle Differenzen zwischen Forschenden und Forschungssubjekten aus deren unterschiedlichen Perspektiven resp. Rollen resultieren können: Das Augenmerk der Forschenden hat zwangsläufig einen breiteren Fokus, während einzelne Forschungssubjekte eine wesentlich engere Wahrnehmung des Untersuchungsgegenstands haben können. In diesem Sinne soll der Ansatz der kommunikativen Validierung als Teil des Forschungsprozesses zur Fehlerreduktion erachtet werden, bei dem das Teilnehmenden-Feedback wiederum zu interpretieren ist (Mays et al., 2000). Die Erfahrungen aus den Forschungsarbeiten zeigen jedoch, dass die befragten Forschungssubjekte in den vorgelegten vorläufigen Ergebnissen keine grossen Widersprüche sahen. Das Feedback erforderte nur geringfügige Modifizierungen und kleine Ergänzungen der theoretischen Bezugsrahmen.

Eine besondere Form der Validierung wurde in der Arbeit 6 durchgeführt. Dabei wurden die vorläufigen Ergebnisse nicht nur den Forschungssubjekten vorgelegt. Darüber hinaus wurden die erarbeiteten Theorie-Entwürfe im Rahmen eines Workshops Fachexperten des RLCP-Netzwerks (Researching Learning for Clinical Practice), das sind Wissenschaftler und Praktiker aus dem Bereich der medizinischen Bildung, vorgestellt und mit diesen kritisch diskutiert. (Für ein ähnliches Vorgehen siehe z.B. Sheehan et al., 2005). Auch dabei führten die konstruktiven Rückmeldungen zu kleineren Erweiterungen und Ergänzungen.

Interkoderreliabilität

Wie bereits im Abschnitt "Interdisziplinarität" beschrieben ist, wurden in die Analysearbeiten mehrere Forschende (aus unterschiedlichen Fachhintergründen) in den Interpretationsprozess involviert. Die Messung der Interkoderreliabilität bedeutet darüber hinaus die quantitative Bestimmung des Grades der Übereinstimmung zwischen den involvierten Forschenden. Dazu wurden in den Beiträgen 5 und 6 Teile des Datenmaterials von zwei Wissenschaftlern kodiert, deren Übereinstimmung überprüft und Abweichungen kritisch diskutiert. Das Verfahren orientierte sich an der Messung der Interkoderreliabilität nach Mayring (2008). Er konstatiert dabei ein Ungleichgewicht zwischen dem Primärforschenden und dem Sekundärforschenden. Ersterer hat zumeist die Interviews durchgeführt und ist oftmals mit dem Material und dem Untersuchungsgegenstand besser vertraut. Deshalb erwartet Mayring nicht einen hundertprozentigen Konsens von weitgehend unabhängig kodierenden Forschenden bei der Textinterpretation und schlägt die Vorgehensweise der "diskursiven Validierung" vor. Dabei führt der Erstkodierende den Zweitkodierenden ausführlich ein. Danach nimmt der Zweitkodierende die Auswertung von (Teil-)Daten anhand der definierten Kategorien vor. Im Anschluss vergleichen die beiden ihre Kodierungen diskursiv, d.h., sie begründen und diskutieren allfällige Abweichungen. Kommen Diskrepanzen durch mangelnden Einblick des Zweitkodierers in das Material oder in die definierten Regeln zustande – und können sich die beiden auf ein gleiches Verständnis einigen – wird diese anfängliche Nichtübereinstimmung nicht bei der Berechnung des Interkoderreliabilitätskoeffizienten berücksichtigt. (Mayring, 2008). Wie von Mayring dargestellt, ergaben sich die meisten Differenzen aus dem weniger tiefen Einblick des Zweitkodierers in den Untersuchungsgegenstand und wurden entsprechend aufgelöst. Während diese Kennzahl aus dem Vergleich von individuellen Analysen resultiert, sieht der Autor, vor dem Hintergrund der durchgeführten Arbeiten, in der gemeinschaftlichen, zeitgleichen Interpretation des Datenmaterials zweier oder mehrerer Forschender einen mindestens ebenso hohen Beitrag zum Erkenntnisgewinn.

"Impact factors" und "ranking" der Journals

Gemäss Thomson Reuters Citation Reports® 2011

1. Academic Medicine
    - Impact 2011: 3.524
    - (1/33) Education, Scientific Disciplines
    - 6/76 Health Care Sciences & Services

2. Medical Education
    - Impact 2011: 3.176
    - 2/33 Education, Scientific Disciplines
    - 8/76 Health Care Sciences & Services

3. British Journal of Educational Technology
    - Impact 2011: 2.098
    - 12/206 Education & Educational Research

4. Advances in Health Sciences Education:
    - Impact 2011: 2.089
    - 3/33 Education, Scientific Disciplines
    - 13/206 Education & Educational Research
    - 30/76 Health Care Sciences & Services

5. Medical Teacher
    - Impact 2011: 1.217
    - 11/33 Education, Scientific Disciplines
    - 50/76 Health Care Sciences & Services

6. International Journal of Mobile and Blended Learning (IJMBL). Seit 2009, noch kein Impact/Ranking verfügbar.

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Running Head: Inter- and intradisciplinary learning in consultations

Title: Learning through inter- and intradisciplinary problem solving: using cognitive apprenticeship to analyse doctor-to-doctor consultation

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ABSTRACT

Today's health care can be characterised by the increasing importance of specialisation that requires cooperation across disciplines and specialities. In view of the number of educational programmes *for* interdisciplinary cooperation, surprisingly little is known on how learning arises *from* interdisciplinary work.

In order to analyse the learning and teaching practices of interdisciplinary cooperation, a multiple case study research focused on how consults, i.e., doctor-to-doctor consultations between medical doctors from different disciplines were carried out: semi-structured interviews with doctors of all levels of seniority from two hospital sites in Switzerland were conducted. Starting with a priori constructs based on the 'methods' underpinning cognitive apprenticeship (CA), the transcribed interviews were analysed according to the principles of qualitative content analysis.

The research contributes to three debates: (1) socio-cognitive and situated learning, (2) intra- and interdisciplinary learning in clinical settings, and (3), more generally, to cooperation and problem solving. Patient cases, which necessitate the cooperation of doctors in consults across boundaries of clinical specialisms, trigger intra- as well as interdisciplinary learning and offer numerous and varied opportunities for learning by requesting doctors as well as for on-call doctors, in particular those in residence. The relevance of consults for learning can also be verified from the perspective of CA which is commonly used by experts, albeit in varying forms, degrees of frequency and quality, and valued by learners. Through data analysis a model for collaborative problem-solving and help-seeking was developed which shows the interplay of pedagogical 'methods' of CA in informal clinical learning contexts.

Keywords: Cognitive Apprenticeship; Consultation and Referral; Cooperative Behavior; Informal Learning; Interdisciplinary Communication; Learning; Problem-Based Learning; Problem Solving; Workplace Learning;

Introduction and Background

Specialisation and interdisciplinary cooperation

Highly specialised health professionals and a need for cooperation are two central characteristics of today's health system: complexities in patient care, technological advances and increasing clinical knowledge are resulting in a great degree of specialisation in health professionals, a greater number of different professions as well as more and more specialties and subspecialties within professions. This, in turn, requires persons with different professional backgrounds to collaborate in order to treat patients effectively (Barr et al., 2005; Hall & Weaver, 2001). Consequently, hospitals can be described as a "collection of highly specialised experts" (Becker et al., 2009) functionally organised into departments (Bardram & Bossen, 2005). Recently there is much attention paid to processes that focus on the need of customers, in particular patients, across these functional units (Gemmel et al., 2008). In medical literature this perspective is reflected, for example, in the notion of patient-focused care or clinical pathways (Vogel, 1993).

Interdisciplinary work in healthcare is, however, not a commonly agreed concept (Lavin et al., 2001). It can include both cooperation between members from the same discipline or profession, for example a team of surgeons and internists, and cooperation between actors with different professional backgrounds such as physiotherapists, surgeons and occupational therapists. Interdisciplinary cooperation involves the solving of a common set of problems where "each member's assessment must take into account the other's contributions to allow for holistic management" (Hall & Weaver, 2001).

A typical example for interdisciplinary cooperation of specialised health professionals across organisational units is a 'consult', a doctor-to-doctor consultation. There, a (requesting) doctor involves an on-call doctor from a (sub-)speciality for a patient case that lies outside his/her expertise. Consults are important and common aspects of clinical practice. Studies report, for example, that in emergency departments (ED) the quantity of cases that require consults is about 40% (Cortazzo et al., 1993); in 7 % of the cases even two consults take place (Woods et al., 2008).

In view of the increasing importance of interdisciplinary work, such as interactions within consults, the main purpose of this research was to explore whether and how interdisciplinary cooperation and problem solving facilitates learning and teaching practices from a socio-cognitive perspective. Accordingly, the research connects to the topics of learning through problem solving, interdisciplinary learning as well as to situated and socio-cognitive perspectives on clinical learning. These topics are introduced and briefly discussed in the following sections:

Learning through (cooperative) problem solving

In the literature importance is afforded to learning through breakdowns and problem solving in the clinical workplace. In a study on the learning of residents in an ambulatory clinic, breakdowns, i.e., "*interruptions in the smooth flow of activity*", were identified as the most important category because of "*their frequency and explanatory power*" (Smith et al., 2004). While effective responses to breakdowns were closely associated with learning, a lack of breakdowns rarely resulted in learning or improvement. Similarly, Slotnick conceives the solving of ill-structured problems as the main route of learning for doctors. He considers learning as gaining insights from a multi-stage problem solving process. He distinguishes *specific problems* that require immediate action from g*eneral problems,* which are associated with more deliberate learning and planning (1999). In order for learners to be able to broaden their competences through deliberate practice, among other things immediate feedback on their actions is considered to be essential. In the medical context this can mean that more experienced colleagues act as providers of feedback or that less experienced colleagues can compare their actions to those of more experienced peers (Ericsson, 2008; Ericsson, 2004). Sargeant et al. (2006), for example, reported that discussions with colleagues about patients were considered fundamental to learning and that in particular residents frequently consulted colleagues in their clinical work: they asked for advice when they deemed their knowledge to be insufficient for treating specific cases. The doctors approached different colleagues according to the particularities of the case and their colleagues' expertise (van de Wiel et al., 2010). In particular during patient encounters doctors tend to ask colleagues for advice instead of studying books or searching the internet (Bennett et al., 2006).

Most of the questions raised by sub-specialists focused on problems outside their specialties (Covell et al., 1985). The literature has little to say, however, about how learning takes place and through what forms of social interaction, i.e. what patterns of cooperation and social practices are in evidence and to what extent they are important for learning to take place.

Learning in interdisciplinary settings

In spite of the increasing importance of interdisciplinary work in health care and the potential of collaborative problem solving for competence development in general, little is known about learning associated with interdisciplinary cooperation. The majority of the studies on interdisciplinary cooperation focus on problems in inter-professional teamwork and the effectiveness of educational measures to address these challenges (Carpenter, 1995; Lavin et al., 2001; Parsell & Bligh, 1998; Sternas et al., 1999). Clinical professionals do not only learn *for* but also *from* interprofessional cooperation. There is, however, much less literature that analyses learning in interdisciplinary settings (Hall & Weaver, 2001). Some studies indicate, for example, that learning by medical students and doctors was facilitated through interaction with nurses (Dornan et al., 2007; Fagin, 1992). While most of the clinical cooperation is dyadic, these forms of cooperation are widely ignored in the interdisciplinary literature (Barr et al., 2005). The focus in the existing literature is placed on educational programmes for interprofessional cooperation in teams, but not on learning from – more loosely framed – intraprofessional cooperation of doctors from different specialties and sub-specialties. The lack of studies that examine interdisciplinary cooperation from a learning perspective can also be confirmed with respect to consults: there are only few studies on consults in general. Most of them are descriptive in nature, lack methodological rigour (Lee et al., 2008) and focus on waiting time and response patterns (Lee et al., 2008; Vosk, 1998). Very little is known about learning that is associated with consults. We identified one paper suggesting that the requesting doctors "value brevity and clarity but they also appreciate consultants who make an active effort to share their expertise" (Goldman et al., 1983). Another study indicated the learning value of bedside teaching of on-call doctors within consults (Salerno et al., 2007).

Situated, socio-cognitive perspectives and cognitive apprenticeship

The understanding of learning in this paper is based on socio-cognitive and situated approaches; they lend themselves particularly well to explaining learning as social interaction in collaborative, complex and unstable systems such as the clinical context (Bleakley, 2006). According to theories of situated learning, context in medical education and practice goes well beyond the physical environment. It should be considered as a complex system that that evolves over time and consists of interactions between doctors, patients and the setting; the interactions are not predictable and non-linear (Durning et al. 2010). Situated learning can provide a helpful framework to analyse social aspects of learning, in particular to understand cooperation and teamwork in medical practice (Patel et al., 2008). CA can be considered as a situated and socio-cognitive approach to learning. It is rooted "intra-individual cognitive processes" but accounts as well for learning that is situated in problem solving and socio-cultural settings (Kirschner, 2006). The main tenets of CA are that learning is actively constructed and situated in order to help learners understand the purposes and meanings of knowledge (Collins et al., 1991). CA intends to make "thinking visible" and is considered an "instructional paradigm" for situated teaching and learning (1991). The approach was developed in the 1980s on the basis of reading, writing and mathematical problem solving (Collins et al., 1991; Collins et al., 1987). Apprenticeship learning is, and has always been, central to medical education (Balmer et al., 2008; Collins et al., 1991; Furmedge, 2008). CA, however, combines the traditional apprenticeship approach with more cognitive methods of education (Collins et al., 1991). CA describes six 'methods' of how a teacher can provide students with the "opportunity to observe, engage in, and invent or discover expert strategies in context", namely: modelling, coaching, scaffolding, articulation, reflection and exploration (Collins et al., 1991). These 'methods' of CA have been used in medical and clinical competence development to design learning environments for students (Woolley & Jarvis, 2007) as well as to analyse students' learning experiences during longer 'clerkships' (Stalmeijer et al., 2008).

Methods

Research questions

On the basis of the existing literature, and on the basis of a socio-cognitive and situated understanding of learning, we formulated the following guiding research questions to explore interdisciplinary learning in the context of consults:

> ***RQ1*** *How do doctors experience consults; who can learn in doctor-to-doctor consultations and to what extent are they considered relevant for competence development?*
>
> ***RQ2*** *How do the pedagogical methods associated with CA facilitate learning in interdisciplinary cooperation such as consults?*

With the first question we intended to explore how doctors experience consultation practices and whether they value them for their own professional learning. Then, in order to analyse *how* learning occurs in and through consults, we used CA, a common frame that includes different teaching methods. To do so, we chose a qualitative case study approach that allows the understanding of complex phenomena such as interdisciplinary cooperation practices that are tightly coupled within the socio-organizational context of clinical environments in which they are situated (Eisenhardt, 1989) and to answer questions of whether, how and why (Giacomini & Cook, 2000) learning takes place. Case studies were considered valuable and popular in healthcare (Baxter & Jack, 2008) as well as in education (Merriam, 1998).

Context and sampling

We chose a multiple case study design to cover potential variations of consultation practices. The research was undertaken in two different hospitals varying in size and scope: one of the largest Swiss university hospitals and a smaller cantonal hospital. Due to the rotation of medical doctors, the participants reported from a much broader range of consultation experiences from hospitals across Switzerland and Germany. We analysed consults between emergency departments (ED) and other

(sub-)specialist departments, due to the broad range of specialists with whom emergency doctors cooperate as well as due to the high frequency of requests for consults (Go et al., 1998). In Switzerland and Germany most of the residents spend time in ED even if they do not intend to specialise in emergency medicine. For this reason, many of the interviewed on-call doctors had worked as residents in the ED and, as a consequence, were able to reflect on consults also from this point of view. While the study was part of a longer research program on clinical cooperation, the interviews took place from January to March 2011. In analysing consults between the ED and other specialities in two different sites and in interviewing all roles involved in consults we used *typical case sampling* (Patton, 2002). To do so, we conducted semi-structured interviews with 10 participants including five (requesting) doctors from the emergency department and five participants who regularly took the role of on-call doctors. Similarly, half of the participants were from a larger university hospital while the other half worked in the smaller cantonal hospital (Table 1).

	(Intended) specialty/ Department	**Seniority**	**Current role in consults**	**Hospital**	**Gender**
01	Hand surgery	Resident	On-call	University Hospital	Male
02	Internal and emergency medicine/ED	Attending	Requesting	University Hospital	Male
03	Pathology/ED	Resident	Requesting	Cantonal Hospital	Male
04	Internal medicine/ED	Resident	Requesting	Cantonal Hospital	Female
05	Orthopaedics, hand surgery	Attending	On-call	University Hospital	Male
06	Geriatric medicine/ED	Resident	Requesting	University Hospital	Female

07	General and hand surgery	Resident	On-call	Cantonal Hospital	Male
08	Plastic and general surgery	Resident	On-call	University Hospital	Male
09	Internal medicine/ED	Resident	Requesting	Cantonal Hospital	Male
10	General surgery	Resident	On-call	University Hospital	Female

Table 1 Description of sample characteristics

Data collection and analysis

The interviews started with open questions about consults. Particular attention was paid to causes, forms of cooperation and processes, roles, technologies in use and frequency. The discussion of themes that emerged during the interviews was explicitly encouraged. Similarly to van de Wiel (2010) we discussed the doctors' perspectives on learning in consults in the second part of the interview. (For the interview guide see the appendix.) The reason for this approach was to avoid bias in relation to what doctors considered relevant for learning as well as in order to enable an analysis from the perspective of situated learning. All the interviews were audio recorded and transcribed verbatim. The data analysis was conducted by four researchers with different backgrounds: three educational researchers with respective expertise in medicine, applied linguistics, social sciences, technology-enhanced learning and one researcher from the political sciences. Similar to Smith et al. (2004) we found it helpful that one researcher (doctor with background in medical education) was an 'insider' in the two clinics and was, therefore, able to interpret findings from the socio-cultural and political context of the research sites. The others acted as 'outsiders' and were, accordingly, able to question things that otherwise might have been taken for granted. The interviews were analysed according to the principles of qualitative content analysis (Mayring, 2004) using the CA methods to guide the coding. In a first round the four researchers analysed and discussed 50% of the data and identified

emerging themes. Then two of the researchers coded all the data using NViVo. Similar to Smith et al (2004) inductive and deductive coding methods were combined: while the coders inductively identified relevant themes to answer RQ1, they took the teaching methods of CA as a priori constructs for a deductive category application. The coded material and the interpretation was, finally, reviewed and critically discussed by all authors until consensus was reached*.

Ethical considerations

Ethical advice was sought from the regional ethical review board. The committee decided that on the basis of the research proposal no further ethical approval was required so long as informed consent was obtained. Anonymity of participants was ensured and written consent was obtained from all interviewees before the interview; and all of them allowed conversations to be audio-taped.

Results

How doctors experienced and valued consults for learning

RQ1 *How do doctors experience consults; who can learn in doctor-to-doctor consultations and to what extent are they considered relevant for competence development?*

Consults: processes and characteristics

Before we discuss learning-related findings, we briefly describe how doctors perceive consultation processes and practices. According to our analysis no such thing as a "standard" consult exists; instead there were a lot of process variations. However, we identified typical patterns that appear to transcend individual hospitals and situations. Consultations were initialised in situations marked by insecurity. In many cases a resident identified a problem for which s/he required expert support from another (sub-)specialism.

- *I carry out a consult when I don't know how to proceed and/or when I'm not sure exactly what to do. [08] ***

Upon approval from the attending doctor, s/he requested the on-call doctor in the specialist department, who was usually a resident. While minor questions were solved on the phone, many cases necessitated on-site examination by the on-call doctor. In case of any further questions residents on-call involved the attendings on-call, acting, in turn, as consultees. Again, the involvement of the more experienced doctor tended to take place in a situation marked by insecurity:

- *It is possible that in the case of insecurities he confers with the senior physician; otherwise he decides for himself. (03)*

In any case they needed to inform their attendings about consults they perform. Once the examinations had been completed, a debriefing took place. Some cases required further post-processing such as referrals, relocations or further medical appointments. Some cases were presented and discussed in team meetings and reports. While a consult was able to involve different roles, the interaction patterns were mostly dyadic. In small hospitals, however, requesting doctors had fewer specialists at hand and often exclusively referred to their attendings.

> *Because [in a small hospital] few specialists are available for consultation [...]. That means that in internal medicine as well as in surgery other disciplines have to be covered as well. [09].*

In general, a consult was considered a common and frequent practice: the doctors in the ED indicated that they needed to consult specialists on a daily basis, with varying frequency depending on the patient census. A resident in the emergency department explained that he requested consults from different specialisms or sub-specialisms on a daily basis, "four to five times on average" (03). He illustrated this by providing the following example:

- *For example, today we had the hand surgeon here four times. The orthopaedist, on the other hand, was not needed. Instead, the urologists were also here twice during my shift today. Those are the most frequent. (03)*

It was reported that most of the residents who worked in clinical settings have to take the role of on-call doctors on a regular basis. As such, they worked on several consults daily, up to 10, as a doctor

from the hand surgery department stated. Another resident with a background in general surgery confirmed the high number of consults. "*Yes, numerous per day. [...] There are many cases daily." (10).* The most active roles in consults were played by residents, who worked in hospitals as part of their specialist training; this makes the need for an analysis of doctor-to-doctor consultation practices from a learning perspective even more significant.

Perceived learning value of consults

The vast majority of participants, in particular residents, identified learning in doctor-to-doctor consultation as central to, and as one of the most relevant activities for their competence development. The solving of complex problems with more experienced doctors, an inherent characteristic of consults, was regarded as the most important learning activity.

- *"I'd say it is amongst the most relevant for learning. […] The joint treatment of patients in the emergency ward with experienced colleagues was the most instructive of the things I've had to do since my exams. " [07].*
- *In between there are a few interesting cases for which one just needs more help and for which one consults someone, someone experienced. In fact, one learns most this way. [01]*

Consults facilitate a broad spectrum of medical and clinical knowledge and skills. They contain and subsume a number of practices relevant to learning for on-call as well as for requesting doctors.

- *One can learn: systematic patient examination, anamnesis, decision-making, therapy: options and alternatives. [01]*
- *It is definitely relevant because it brings together everything one does throughout the day. From interpreting laboratory values and images through anamnesis and examination finally decision making. Everything we do is part of it. [04]*

The specialist knowledge involved appeared to be fascinating for requesting doctors. In particular inexperienced doctors deemed the opportunity to interact with specialists to be valuable and highlighted its relevance for learning.

- *It [the knowledge of the consult] is specialised knowledge which means it mostly is detailed and therefore fascinating. [09]*
- *I find it very exciting because you talk to the specialists in the field. I am still a blank canvass. I still have little idea about surgery or orthopaedics as I started here only recently. That is why I learn a lot. [06]*

Some particularly appreciated consults with experts from specialisms or sub-specialisms close to their intended specialisation. These were of greater interest and tended to lead to a more intensive engagement, for example in the form of questions to the on-call doctors.

- *[…] more in the areas in which one has developed further. They tended to interest me more and one is more likely to probe further. [05]*

Also on-call doctors considered consults as unique learning opportunities. While they usually exercised less responsibility in their departments, in making or confirming a diagnosis in the context of a consult they had to act as frontline 'experts':

- *In terms of patient care in the context of consults one is in the frontline. Particularly as resident, because one is on-call, has to think and show presence. In such situations one is initially more involved in the process compared with patients having been admitted for stationary treatment already and been treated or operated on by more experienced colleagues, senior doctors or head doctors. [08]*
- *I consider it very relevant for learning because one is being called to consult as someone who works here but with limited experience. [07]*

Both residents in the role of on-call and requesting doctors valued the feedback they received in consults. They found it particularly helpful that they received feedback upon their own problem-solving processes that allowed them to contrast their own practices and concepts with the approaches of experts. They deemed this a unique learning opportunity provided in the context of consults.

- *Of special significance is that one has already seen the patient and that one has already formed an opinion before the specialist arrives. It is as if you get a corrected exam back. [04]*

While also senior doctors stated that they can learn from consults, they were considered to be most relevant for the learning of residents.

- *I think that everyone can benefit. Ideally it is important for the resident doctor who is still in training. [02]*

Cognitive apprenticeship methods in doctor-to-doctor consultation

RQ2 *How do the pedagogical approaches associated with CA facilitate learning in interdisciplinary cooperation such as consults?*

In the next step, we analysed if the value of consults for learning can also be confirmed from the perspective of CA, which is widely considered to be a useful instructional paradigm when experts need to explain complex tasks to learners (Collins et al., 1991). Consequently, we took the 'methods' of CA as an analytical framework. We individually examined how each 'method' was applied in the context of consults in terms of frequency, form and quality.

Modelling

In modelling learners observed experts who were performing and explaining tasks. While it is acknowledged that physical activities – which also embody important cognitive skills (Brown et al., 1989) – can to some extent be learned through observation, in non-physical domains experts need to externalize their mental processes more explicitly (Collins et al., 1991). All participants reported the latter form of modelling, as requesting doctors always received the advice of on-call doctors. ED residents recognised the value of modelling for their learning and also on-call doctors confirmed that point of view. There was, however, much variance with respect to the quality of the feedback of modelling: the range was from short text messages to detailed and rich oral explanations and sketches of the reasons underlying problem solving. The latter was deemed to be very relevant for learning.

- *Sometimes it is very instructive when an orthopaedist explains what sort of fracture is in evidence and how to treat it. It is instructive because one can develop the confidence to have a*

go oneself. Sometimes it is very informal: 'Do this and this.' This is the range of possibilities. [03]

Oral explanations that were accompanied by physical demonstration directly at the bedside were also highly appreciated. In the data there was comparatively little evidence for that form of bedside teaching. While residents both in the role of requesting and as on-call doctors definitely appreciated active forms of modelling as learners, they indicated that they benefited even without explicit teaching by experts, by simply listening to and observing the experts.

- *I also learned during examinations. It is fascinating how they approach a clinical examination.* [10]

The extent to which modelling can take place was significantly determined by workload and the availability of time. First of all, requesting doctors in the ED needed to have the time to take part in the examination of the patient by the on-call doctors. In emergency departments which account for a large number of cases and which are characterised by overcrowding (Derlet et al., 2001), it cannot be taken for granted, as one doctor explained: *He [on-call doctor] then goes to the patient. I mostly try to come along if I have the time to do so*. [04]. The quality of modelling, i.e. the extent to which the on-call doctors make their thinking explicit, is also strongly dependent on workload.

Coaching

Coaching is described as observing learners while they carry out tasks and offering advice (Collins et al., 1991). In the domain of physical tasks we hardly found any evidence off coaching. If the requesting doctor took part in the physical examination of the patient, in most cases the more experienced (or specialist) doctor led on the patient treatment. This facilitated learning by *modelling* which we discuss above. "*He [the on-call doctor] introduces himself and depending on the case he carries out an examination.*" [09]. Considerably more often the requesting doctor received feedback and advice when he articulated the case via telephone or in situ and suggested a treatment. This held particularly true for on-call doctors when they involved their attendings and learned in an intradisciplinary setting.

- *And a second learning effect is that I also frequently phone the attending doctor in the background and he gives me additional feedback as to whether he agrees or if an alternative treatment is advisable. For me, as the person being called to the consultation, it is very instructive."[07]*

Scaffolding

Scaffolding is the interactional and meditational support the teacher provides to the student. In the context of consults, scaffolding was triggered by the learner. This allowed for scaffolding in loosely-coupled, interdisciplinary cooperation between different departments. In this sense, scaffolding can be considered as an inherent part of a consult: requesting doctors triggered scaffolding in case they felt that they were not capable to manage the situation on their own. In involving (sub-)specialties on demand, consults were described as practices where the requesting doctor had to decide on when to use scaffolding that, again, can lead to modelling.

- *I seek consultation if I don't know how to proceed or if I am not sure what I should do exactly. [04]*

Subsequently, the form of scaffolding was decided on, for example, if there was a need for 'on-site scaffolding' or if the requesting doctor was able to be supported via telephone. In most cases of interdisciplinary consultation, the on-call doctors needed to see and examine the patient personally. The same was true for an on-call resident when involving her/his attending. Also, scaffolding was provided in the form of telephone consultation or through on-site support. More telephone-based scaffolding was involved in this form of *intra*disciplinary cooperation. According to Collins et al., scaffolding is closely linked to fading which means "the gradual removal of supports" (1991). There was much evidence that successful scaffolding prepared the learner for similar cases in the future and, that more experienced doctors involved the specialists less often.

- *In the process one learns, one considers a possible treatment, makes the call, explains the case and proposes a course of action. Then one gets the go-ahead and one knows by implication*

whether one has deliberated correctly. Or they give further advice for future reference. That way one can optimise everything. [08]

Articulation

Articulation involves any method of getting students to articulate their knowledge, reasoning, or problem solving processes (Collins et al., 1991). Some on-call attendings reported that they actively and deliberately tried to get residents to articulate their concepts and to make suggestions for further procedures in order to support their learning within a consult. The example below shows that articulation was not limited to members of the respective discipline but can also include ED residents:

- *I also always try to elicit therapy suggestions from the resident, ascertain what he would do, what treatment he would recommend. [...] That way he can develop his own approach for dealing with such problems. [...] So one would say 'the patient has a flexor tendon injury' and then one asks the resident from the ED how he would treat such an injury. [...] We would ask our own residents more searching questions. [05]*

However, even without deliberate teaching intentions the consult required requesting doctors to communicate their view on the problem and possible problem-solving strategies over the phone to the on-call doctor. This was also the case for on-call residents who involved their attendings and articulated the case.

- *The caller says where the call comes from, name and date of birth of the patient, why he is hospitalised, what happened, why a particular specialist is needed and what he thinks the problem is. [04]*

Reflection

According to CA, student reflection is stimulated by comparing "their own problem-solving processes with those of an expert, (or) another student" (Collins et al., 1991). This is also part of consults, where learners have the opportunity to observe experts' procedures (in the sense of modelling) and compare them to their previous approaches. This is also the case in the acquisition of non-physical skills, where

learners can compare their cognitive concept to the solution favoured by the expert. We found evidence that in consults learning from *reflection* by both requesting doctors and on-call doctors was very much triggered by potential errors where their ideas and mental concepts of how to solve the problem differed considerably from that of the experts.

- *This is exactly the engramme which one prepares oneself. Then, the expert tells you otherwise. This means one's trail of thought was erroneous. One remembers that. [06]*

In consults there exist no techniques to 'replay' the performance of both expert and novice for comparison as favoured by Collins et al. (1991). However, doctors engaged in post-hoc reflection by discussing their experiences with colleagues and by reading case-related material.

- *If one discusses a case again and if one reads after the discussion through the symptoms or the injury patterns again in the textbook, one can make a mental note of it.* [08]

Exploration

CA understands exploration as pushing students into a mode of problem solving on their own. It includes fading in problem solving and fading in problem setting (Collins et al., 1991). In the context of consults both requesting doctors and on-call doctors were pushed into problem solving. To a certain extent they needed to treat patients independently and take decisions on their own. Sometimes on-call doctors decided on (the degree of) exploration in that they determined whether the requesting doctors can treat the patients on their own:

- *[…] then the* on-call doctor *comes by and looks at the patient. According to the situation he tells us to treat ourselves. [06]*

The degree to which residents took responsibility and engaged in exploratory learning, however, was only guided by experts to some extent. It also depended on the interplay of a number of organisational and situational factors such as role, size and scope of the hospital. As we have already indicated, the role of an on-call doctor (and not the explicit instruction of an expert) allowed a high degree of learning by exploration in that, for example, a relatively inexperienced on-call doctor independently saw and examined patients. Also, the role of ED residents, who acted as requesting doctors, included

much exploration, particularly in smaller hospitals. There, due to the limited availability of specialties, residents engaged very much in learning by exploration. In addition, the extent of exploratory learning also depended on the organisation of shifts. During night shifts there is a limited availability of experts in many hospitals. And finally, exploratory learning, in particular for relatively inexperienced doctors, was not only common in consults, but also deemed to be highly relevant by both requesting doctors and on-call doctors for their own learning.

- *At the moment in most instances I decide what the patient needs and what the treatment is. I initiate things. [...] If you do it the first time, that means a very different degree of pressure and concentration. One learns a lot like that. [01]*

In the context of consults we did not, however, find an explicit setting of general learning goals and no encouragement to focus on sub-goals of particular interest by the teacher, as suggested by CA to support and guide exploration (Collins et al., 1991).

Discussion

In the following we discuss the results from various theoretical perspectives. First, we contrast our findings with related studies on medical and clinical problem solving. Then we introduce a model that we developed to better illustrate the interplay of pedagogical features of CA in the context of collaborative and interdisciplinary problem-solving. This is followed by a critical discussion of the CA in the context of interdisciplinary cooperation. Finally, we analyse and discuss influences on the 'methods' of CA other than deliberate, teacher-driven actions such as contextual factors.

Perceived value of inter- and intradisciplinary problem solving for learning

There is much evidence in the data that cooperation of doctors across disciplines in the form of consults is not only a common and frequent phenomenon of contemporary patient care, but is central to medical and clinical competence development. We showed how complex medical problems, which are treated across departmental boundaries can trigger rich forms not only of interdisciplinary but also of intradisciplinary learning. This is particularly the case for residents who work in hospitals as part of their educational curriculum and often act as requesting doctors as well as on-call doctors. Doctors in

both roles can learn in or from consults. The study reinforces the importance of problem solving and ’breakdowns’ for learning. The findings can, for example, be related to Slotnick’s conceptualisation in that the process of a consult is considered as learning linked to specific problems which takes place ad-hoc and relates to a specific need. Smith et al. (2004) also describe „effective responses to breakdowns that were closely associated with reflexive relearning“. Therefore, consults might be viewed as effective responses with relevance for learning because the resident encounters a problem which s/he can solve with the help of a more experienced doctor. In this way, as we have shown, a number of activities relevant for learning can be triggered. In addition, the relevance of 'near-miss errors’ in the context of consults becomes evident: doctors describe how they learn in doctor-to-doctor consultation through mistakes they nearly made had it not been for the consultation of a more specialised/experienced doctor.

Interplay of pedagogical methods of CA

Whilst we have not so far explored social interaction, i.e. practices of relevance for teaching and learning with experienced colleagues, in any detail, we were able to show with references to CA how doctors learn from a socio-cognitive perspective in the context of consults. Experts can – in their role as teachers – stimulate learning practices by using the pedagogical approaches of CA within the context of consults they provide opportunities for modelling, reflection and scaffolding, engage in coaching, get the learners to articulate their knowledge and push them to problem solve. This appears to take place according to certain patterns, which we will discuss in the following sections. (see also Figure 1).

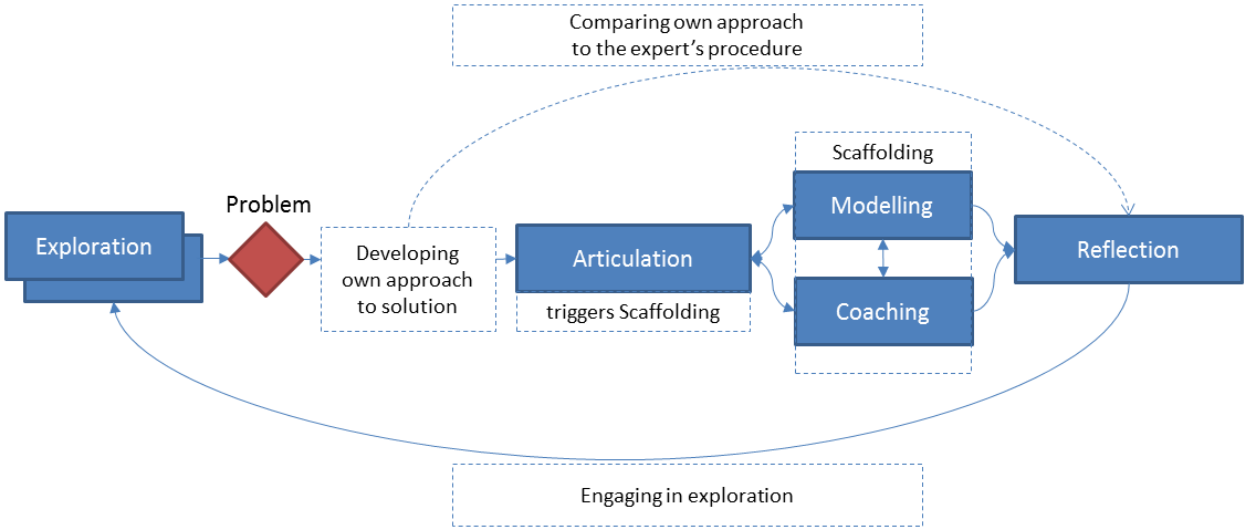

Figure 1: Model of CA methods in doctor-to-doctor consultations

Typically, CA does not begin with modelling but with **exploration**: residents (requesting doctors as well as on-call doctors) first of all have to master a task by themselves. If they encounter a problem, they are required to articulate it together with possible solutions to an experienced and/or specialist colleague (**articulation**). This way they trigger different types of **scaffolding** in the form of **modelling and/or coaching**: if a doctor involves the on-call doctor, the latter normally comes to ED and examines the patient. She or he cannot only make decisions, but through modelling explicate underlying considerations as well as demonstrate practices of diagnosis and treatment in relation to the patient. If the on-call resident involves her/his attending over the telephone, s/he also articulates a possible treatment solution and is being coached through suggestions, hints and feedback. Then, the attending on-call can also come to the ED and can enable learning by modelling in situ. And although on-call doctors tend to involve their attendings more over the telephone that through on-site modelling, it becomes clear that the interaction patterns around help seeking by residents in the ED and on-call doctors involving their attendings are similar. Reflective learning in CA terms is triggered in that residents compare their treatment solutions with those of experienced (specialist) doctors and receive targeted feedback (**reflection**).

The application of methods is not necessarily linear but can be iterative. Articulation, for example, can recur during the examination of the patient, after coaching on the telephone. Modelling can follow on from coaching, for example, if the doctor offering advice does so in the form of coaching tips and

feedback over the telephone and subsequently in the ED through direct observation; the same applies to the on-call resident who involves his/her attending. This demonstrates how much approaches to and quality of learning are dependent on clinical processes.

Critical appraisal of CA in the context of interdisciplinary cooperation

In taking a critical look at CA as a tool for analysis, one needs to note that the teaching methods are interlinked and cannot be easily separated: Collins et al. consider coaching as "observing students while they carry out a task and offering hints" (Collins et al., 1991); similarly, they describe scaffolding as "the supports the teacher provides to help the student carry out the task. These supports can take either the forms of suggestions or help" (Collins et al., 1991). Consequently, in the model above *coaching* is depicted as a form of *scaffolding* and (even) *modelling* can be considered as *scaffolding* if it is triggered in a problem-solving situation. In addition, the methods are tightly linked and connected as the following example shows: if a learner articulates a solution to a problem and receives feedback, this can, in turn, be considered as coaching. These similarities and interrelationships make a clear and disjunctive categorisation difficult. This does not, however, limit the value of CA as an approach that can guide teachers – or experts – and helps them to engage in relevant teaching practices. Accordingly, the value of CA is not restricted to formal learning settings with more or less explicit learner-teacher relations such as schools. CA can also help experts/teachers to stimulate more explicitly student learning in informal learning contexts such as problem solving and cooperation in clinical settings.

An explorative approach to learning and teaching, with which CA could be expanded, is for less experienced doctors in a specialist discipline to assume the role of experts. Collins et al. (1991) considered „‚reciprocal teaching', where teacher and students take turns playing the role of teacher," as very effective in context of reading acquisition. Interdisciplinary cooperation in the form of consults goes beyond that in so far as the coach is no longer present and the learners (residents on-call) have to assume the role of an expert in relation to third parties, which tends to be instructive and motivating. In this context the availability of an expert, who can assist in case of uncertainties, is essential.

CA methods: teacher- or context-driven?

The findings also show that, similarly to results reported by van de Wiel et al. (2010), learning and teaching in general and in particular the application of the six 'methods' of CA only partly take place deliberately. Accordingly, much could be gained, we would argue, by managing learning and teaching opportunities more explicitly. In order to leverage consults for learning, experienced and specialist doctors have to be aware of its huge potential and explain the underlying reasons behind their problem solving. In this sense, externalisation of knowledge or – in CA terms – 'making thinking visible', is central to learning by solving problems in doctor-to-doctor consultations.

Howver, beyond deliberate actions of experts or teachers, learning and teaching practices are also very much driven by the consultation process per se and are influenced by other situational and organisational variables: for example, modelling can be considered an inherent part of consults, as the process per se requires feedback and explanations from the on-call doctor to the requesting doctor. We also found evidence that time and workload and the organisations of shifts impact on, for example, whether bedside teaching and modelling actually take place, i.e. whether the requesting doctor can accompany the on-call doctor during the patient examination, or whether the attending of the latter can explain and 'model' in situ; and, to what extent the actors involved in consultations make their thinking explicit to each other. Also, scaffolding and coaching are more often triggered by the learner in case of insecurities and questions in the process of treating a patient than by deliberate teaching intentions. Furthermore, we found many examples for process-driven articulation in consults. In these contexts, articulation can be considered more as a necessity of inter- and intradisciplinary cooperation processes than a deliberate articulation method applied by experts to stimulate residents' learning. Requesting doctors, for example, have to articulate relevant case details as well as their perspectives on the problem over the phone in order to inform the on-call doctor at the beginning of a consult. Reflection appears also to be very much stimulated by the responsibility and the role that relatively inexperienced on-call doctors have to take in consults as well as by "potential errors". Similarly, the extent to which residents learn through exploration seems to depend on situational and organisational factors such as role and responsibility as well as on other factors such as size and scope of the hospital.

Limitations and outlook

We consider consults as typical and suitable practices to explore learning from the perspective of interdisciplinary co-operation and problem solving. It has to be acknowledged, however, that they represent just one possible form of interdisciplinary work. Whilst we discussed here in the main learning and teaching practices in inter- and intradisciplinary cooperation, we explored significance and interplay of situational, organisational and procedural factors rather selectively. With respect to methodology our research was exclusively based on interviews, and therefore on self-reported and perceptual data, and did not use any other form of qualitative or quantitative data collection.

While we considered all roles which are typically involved in emergency consults and while we conducted research in two hospitals varying in scope and size, we involved a rather small number of interview partners from two cultural settings. These limitations might be considered as sample bias und must be taken into account when generalising the findings for other contexts. From a theoretical perspective, CA is a broad and pragmatic frame which integrates a number of recognised approaches to teaching and learning. It should be noted, however, that the same approaches are discussed in a more differentiated and profound way in (research) literature not associated with CA. For example, there exists a significant body of literature on mentoring and coaching across a range of disciplines; the notion of scaffolding was discussed by the cognitive psychologist Jerome Bruner and colleagues (Wood et al., 1976) drawing on the work of Lev Vygotsky; or, Schön (1983, 1987) developed a sophisticated concept of reflection in relation to work practices. A detailed theoretical engagement with these pedagogical approaches, though desirable, would go well beyond the scope of this paper.

In view of the focus and thematic limitations of this paper we encourage future research to consider learning that may arise from other forms of interdisciplinary and interprofessional work such as interactions in operating theatres, less formal co-operation between actors of different disciplines or professions, and consults between departments that are not centred on emergency wards. We also propose that further research should expand the geographical and cultural scope. From a methodological perspective we would suggest participatory observations and ethnological approaches

so as to contrast and triangulate the perceptual data with observational data. As indicated, we were able to explore the significance of situational, organisational and procedural factors rather selectively. Accordingly (and as we would argue most importantly), future research should explore these correlations more in-depth. Therefore, we would suggest theoretical triangulation by using other socio-cognitive and situated approaches such as distributed cognition or ecological theories in order to better explore the interplay of contextual factors and learning (see, for example, Durning et al. 2010, Nardi, 1996). In addition, we would propose using grounded theory and approaches that develop theory (rather) inductively from a corpus of data in order to identify themes and particularities of the clinical context not covered by existing theoretical concepts.

Conclusion

Against the background of increasing specialisation in the field of health care and the resultant necessity for interdisciplinary cooperation, we analysed in this paper how, and to what extent the cooperation between hospital doctors across departmental boundaries impacts on their learning and competence development. We have shown how more complex patient cases, which are treated in the context of consults, facilitate rich forms not only interdisciplinary but also intradisciplinary learning. On the one hand the doctors participating in the study considered cooperation in the context of a consult as one of the most relevant clinical activities for learning as it presents numerous and varied opportunities for learning both for the requesting doctor as well as the on-call doctor in particular if residents occupy both these roles. The findings confirm existing studies which consider the solving of problems in everyday clinical practice as very relevant for learning. Research to date has tended to focus on individual and cognitive-psychological aspects of clinical problem solving and has only sporadically noted the importance of social interaction and attendant teaching and learning practices in the context of problem solving. The present study has, therefore, attempted to combine social and cognitive perspectives with reference to cognitive apprenticeship. The results show how experienced doctors assume a teaching role making use of the pedagogical approaches of CA, partly deliberate, but in varying form, degree of frequency and quality and thereby stimulate learning in other, less

experienced doctors. Accordingly, CA may be able to assist experts also in fostering the learning of less experienced colleagues in informal learning contexts such as a clinical setting more deliberately. Whilst we discussed here in the main learning and teaching practices in inter- and intradisciplinary collaboration and whilst we could only explore the significance of situational, organisational and procedural factors rather selectively future research should explore these correlations in more depth.

Appendix: Interview guide

Consults: processes/characteristics/interactions

- How do you experience consults? Please explain a typical consultation process as detailed as possible/ step-by step

If not already addressed, the following sub-questions are discussed:

- How and why/in which situations is a consult initiated? Please provide examples.
- Who/what role/s is/are usually involved in consults?
- What are responsibilities attached to the roles?
- Are there different forms of consults? Is there variation in how a consult takes place?
- How often are you involved in consults?
- How do you interact with doctors in a consult? Please provide examples.
- What tools/media are involved in consults?

Perceived learning & consults

- What is you understanding of learning?
- How do you learn in/through your clinical practice? Please provide examples.
- Do you learn something in/through consults?
- How do you learn in consults? Please provide concrete examples/situations.
- Do you think other actors involved in consults can learn?
- How do other actors involved in consults learn? Please provide concrete examples/situations.

- What do you learn in/through consults? What sort of knowledge/skills/competences etc. do you gain in consults? Please provide examples.
- With respect to learning: are consults more (or less) relevant compared to other clinical activities? Why? What are particularities of consults?
- In which situations do you learn best in consults? Please provide examples.
- With/from whom do you learn in consults?

Notes

* One author (NP) translated the interview data from German into English

** The number after each quotation links to the respective study participant. For example [01] refers to participant with the number 01 in the table 1 "Description of sample characteristics".

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Towards Work-Based Mobile Learning:
What We Can Learn from the Fields of Work-Based Learning and Mobile Learning

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ABSTRACT

Mobile devices are increasingly being used to support learning in work contexts. In exploring the emerging field of work-based mobile learning (WBML), researchers need to give consideration to the theoretical and empirical findings from mobile and work-based learning. In this paper, the authors provide an overview of key issues and dominant debates in these fields with the aim of providing a systematic introduction for mobile learning researchers interested in exploring the use of mobile devices for learning in work-based contexts. This paper's focus is aimed at scoping possible commonalities across mobile and work-based learning in order to establish a baseline for future conceptual work in empirical research towards WBML.

Keywords: *Literature Review, Mobile Learning, Theoretical Approaches, Work-Based Learning, Workplace Learning*

MOBILE LEARNING

An Emerging Field

Today mobile technologies such as cell phones are widespread and multifunctional, mobile broadband coverage has improved considerably in recent years and smartphones are combining more and more capabilities – ranging from telecommunication and video capturing to personal information management (Livingston, 2004); this important characteristic is referred to as convergence in the literature (Pachler, Bachmair, & Cook, 2010). At the same time costs for telecommunication have been decreasing (compare e.g., European Statistics Eurostat, 2008). Mobiles – such as the iPhone – were identified in recent Horizon Reports (2009, 2010) as the technologies with the highest likelihood of entry into the mainstream of learning-focused institutions within the next year. Whereas mobile devices have become more and more embedded in the life worlds of learners, schools have mostly not considered

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them as cultural resources (Pachler, 2009; Pachler, Bachmair, & Cook, 2010). Similarly, companies seem to be hesitant to acknowledge the potential of mobile technologies for learning (Härtel et al., 2007) despite the high penetration of mobile devices also in the business environments (Dzartevska, 2009).

In line with the spreading of mobile technologies, mobile learning is a rapidly expanding field of research (see e.g., Vavoula, Pachler, & Kukulska-Hulme, 2009). Its growing importance is reflected, for example, in the rising number of conferences [1], journals and books [2]. A number of mobile learning projects have been piloted in schools and institutions of Higher Education (see e.g., http://www.moleap.net; for a state of the art analysis of mobile projects compare e.g., Frohberg, 2006; Frohberg et al., 2009; Pachler, Bachmair, & Cook, 2010; Seipold & Pachler, 2010). Some projects have also been conducted and researched in business contexts (see e.g., Pimmer & Gröhbiel, 2008; Pachler, Pimmer, & Seipold, forthcoming).

Definitions and Theoretical Concepts

At present there is no dominant definition of what constitutes mobile learning. Particularly in the early days of work in the field, mobile learning was often conceived of as a technological concept (based on portable technology) (Kukulska-Hulme et al., 2009) and to the delivery of content to mobile devices (transmission based-learning) (Frohberg et al., 2009). Today, contextual factors are considered to be of great significance. This is also mirrored in some commonly used definitions where, for example, mobile learning is considered as "the processes of coming to know through conversations across multiple contexts among people and personal interactive technologies" (Sharples et al., 2007, p. 158). Our perception of mobile learning is based on a similar understanding: we characterise it as the processes of coming to know, and of being able to operate successfully in, and across, new and ever changing contexts with and through the use of mobile devices. Instead of a technical orientation today's focus is on an educational perspective, given the affordances that mobile devices provide for meaning-making (Pachler, 2010; Pachler, Bachmair, & Cook, 2010).

Activity Theory (AT) is well acknowledged in mobile learning and many researchers have used the model as an explanatory frame for exploring learning with mobile devices. Of particular interest seems to be the triangular activity system of Engeström (1987). Despite its prevalence in the literature, AT has been criticised for not being an adequate theory for researching mobile learning: on the one hand it lacks the necessary simplicity to be of value for practitioners and policy makers; on the other hand (from a theoretical perspective), the notion of learning as the acquisition of objects, as well as the distinction between learning subjects and objects, is considered as problematic (Pachler, Bachmair, & Cook, 2010). In their article on Folksonomological Reification, Parslow et al. (2008), suggest that it is important to modify the AT 'triangle' for use with social tools relating to learning practice.

> *The reason being that the revised version seems (...) to emphasise the importance of the links between community and tools. Additionally, it can be argued that with social media (Web 2.0) style tools, the tool being used is really the information which has been contributed by the community rather than the underlying 'code' which quickly reaches the status of infrastructure. With this view, the tool itself is in a continual flux, changing and adapting to the environment through use. (ibid)*

Pachler et al. (2010) favour a focus on the subject rather than the object. While they do not consider the object as irrelevant, they underline the relevance of content and context. Learning objects are viewed as cultural products and in this function they are equivalent to generated contexts.

Coming from a socio-cognitive engineering design perspective some authors (Sharples

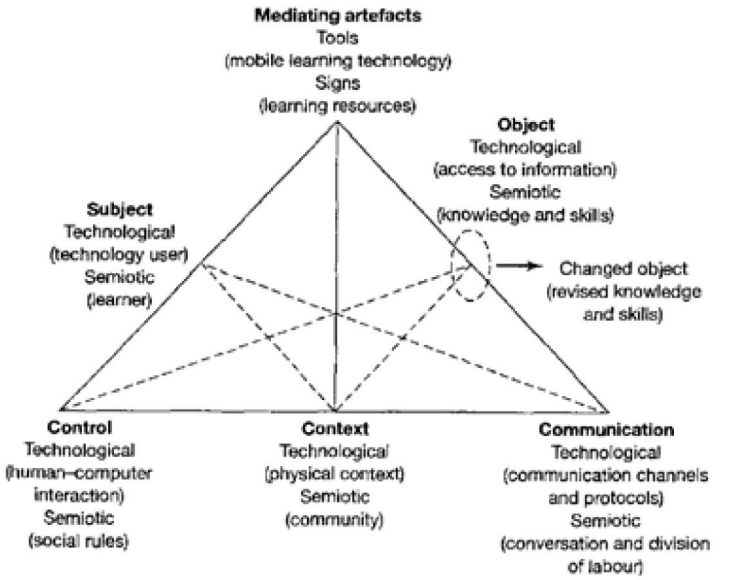
et al., 2005; Sharples et al., 2007) argue that Engeström's model insufficiently emphasises that learning is an internal and external conversation, that activities are contextual and that human activity systems have reflexive potential. On the basis of this they developed a theoretical approach as a synthesis of AT and the conversational framework of Laurillard (2002, 2007).

The discursive 'conversational framework' model explains the learning process as being akin to a 'conversation' between the teacher and the student that operates at a discursive and interactive level linked by reflection and adaptation. The conversations take place with the external world and its artefacts, with oneself, and also with other learners and teachers.

Sharples et al.'s (2007) framework (Figure 1) has been criticised of late for not sufficiently acknowledging learning as practice as well as the notion of context (Wali et al., 2008). The authors also question the need to introduce two layers for the semiotic and technological dimensions of activity. While they, too, draw on AT, they put a stronger focus on the continuity of learning activities between and across contexts (physical and social) which they describe as 'context crossing'. They point out the importance of considering context both in terms of environment as well as the social setting of the learning activities. Compared with Sharples et al, the tool dimension becomes subsumed under the concept of 'location'. Pachler, Bachmair and Cook (2010) agree with their emphasis on learning and practice across contexts. However, they criticise that the tool dimension is subsumed under the concept of 'location'. This, they argue, denies the importance of conceptual tools such as language or other semiotic means. Moreover, they criticise Wali et al.'s framework as remaining too abstract and insufficiently connected with the socio-cultural changes and the changes in the mass communication structures that are currently taking place within the context of an individual risk society. (For a detailed discussion of theoretical approaches to mobile learning see Pachler, Bachmair, & Cook, 2010).

In response to the perceived need for a comprehensive theory of mobile learning and in view of the limitations of AT, a socio-cultural approach to mobile learning was developed by the London Mobile Learning Group (Pachler,

Figure 1. Modified activity system (Sharples et al., 2007)



Bachmair, & Cook, 2010; Pachler, 2010). The conceptual frame of the LMLG of a 'socio-cultural ecology' has links to AT, for example, in that it is premised on notions of learner agency, i.e., intent and motivation, which can manifest itself in object-orientated activity systems. The LMLG agrees with Wali, Winters, and Oliver (2008) who foreground the importance of location and context. However, the group views learning in an ecological environment of *agency*, *practices* and *structures* (see Figure 2). Stressing the importance of learning as participating in cultural practices, the authors widened Giddens' binary model (1984) of structures and agency, which has also been used as conceptual framework in the field of WBL, into a triangular one, which includes cultural practices.

They understand *agency*, as the user's capacity to act on the world. Agency manifests itself as the learner's social and semiotic capacity, i.e., their ability to form relationships with others (mediated by technology) as well as to use media for meaning making and developing representations of the world. Agency is related to the formation of identity and subjectivity, i.e. with the processes attendant to the development of a distinct way of being in the world with and through the use of mobile devices. Accordingly, agency is linked to the use of mobile devices in relation to one's own, rather than necessarily predetermined ends.

The authors place centrality on *practices*, which can be viewed as a learner's engagement with particular settings. Cultural practices are seen as the routines users engage in their everyday lives: routines both in terms of media use in everyday life such as socialising, networking, play, entertainment etc as well as the pedagogical practices around teaching and learning in the context of educational institutions. They see acceptable behaviour in the use of mobile devices linked to social norms in the context of wider cultural practices surrounding the use of mobile devices. Traditional regulations of public and private spaces are being renegotiated.

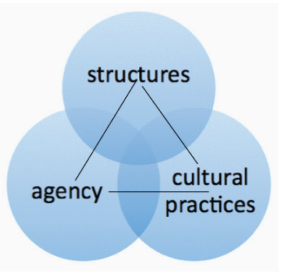
The third important node of the triangle consists of the *social and technological structures* that govern the user's being in the world. Pachler (2010) and Pachler, Bachmair, and Cook (2010), for example, highlight the way in which risk is being increasingly individualized in the context of the provisionality and flexibility as a structural feature. Or they consider the importance of media related structural features of the convergence of mobiles and their applications with the internet.

For a more detailed description of the approach see (Pachler, 2010; Pachler, Bachmair, & Cook, 2010).

WORK-BASED LEARNING

Let us now turn to work-based learning. As we have noted at the outset, in order to start to delineate how WBML might be characterised, it is important to understand theoretical and conceptual approaches not only in the field of mobile learning but also in the field of work-based learning.

Figure 2. The socio-cultural ecological approach of the London Mobile Learning Group



A socio-cultural, ecological approach

Relevance and Scope

The nature of organisations and work has changed considerably in the last decades. There is a stronger need to cope with greater job insecurity, greater job mobility and technological changes (Mulholland et al., 2005). For example, mobile technologies alter the nature of (knowledge) work as well as the balance between training and performance support (Traxler, 2007). Transformations caused by mobile phones can result in greater efficiency and supervision but also in the weakening of home and work boundaries (see also Traxler in this edition). Other examples for alterations are downsized companies that virtually cooperate in the value chain with partners in short and long term alliances (Carayon & Smith, 2000). These trends also impact on competence development and on workplace learning (Mulholland et al., 2005): smaller companies, for example, may not have sufficient resources to adequately support their employees' competence development and, the virtual cooperation leads to learning and knowledge sharing across company borders (Bal & Teo, 2001). Mazzoni and Gaffuri (2009a, p. 1) point out:

In this context, which is characterized by short terms of reaction to environmental changes, by inter-organisational mobility, and by weak connections between individuals and organisations in which they operate, a greater flexibility in the use, in the transfer, and in the integration of personal knowledge and social competences is required. […] the rapidity of the knowledge evolution, of the transfer and of the obsolescence tends to break the sequential nature of traditional training courses (models based on the transmission of repetitive competences isolated by contexts, the acquisition of behavioural schemes or movements automation) that nowadays seem to be obsolete and involved in marginal professional contexts.

They go on to say: "In contexts characterised by this speed of change, the classic refresher courses risk being characterised by simple portions of contents encapsulated in knowledge sets exposed to ageing processes difficult to predict" (Mazzoni & Gaffuri, 2009b, p. 1405).

These examples show the growing importance of learning that takes place outside conventional personnel development structures of organisations.

Job skills have risen significantly in the last decades: on the one hand, the number of jobs with little induction time has declined. On the other hand, more and more employees indicate that their job requires them to constantly learn; and employees see themselves increasingly helping workplace colleagues to learn new things. This evidence suggests that workplaces themselves are becoming a more and more important driver for learning (Felstead et al., 2007). Learning in work-contexts is considered as crucial in today's learning society (Evans et al., 2002).

However, it is recognised that these potentials are not simply met by acknowledging that "learning occurs at work: both the practices and discourses of workplace learning require both understanding and development" (Lee et al., 2004). In this context it has to be taken into account that the main objective of many organisations is not learning but the profit-orientated delivery of services and products. Learning makes a crucial contribution to it, but its importance might be underestimated because it is (in some contexts) difficult to separate from daily work-practices (see Unwin & Fuller, 2003, p. 3).

There exist a variety of different and even contradictory approaches to workplace learning (Lee et al., 2004, Kersch & Evans, 2006; Jacobs & Park, 2009) and work-based learning (Kersch & Evans, 2006; Evans et al., 2010; Burke et al., 2009). This paper is based on an inclusive notion of work-based learning "bridging embedded workplace learning perspectives and those that frame work-based learning as a class of programmes" (Evans, forthcoming). In this sense, work-based learning refers to expanding individual and collective human capacities in the context of employment (including also forms of self-employment, unpaid employment as well

as voluntary forms community organisation) *learning in, for and through the workplace* (drawing on Evans et al., 2010; Evans & Kersh, 2006; Kersch & Evans, 2006; Evans, 2009). Work-based learning can, accordingly, relate to placements as part of education courses, to (semi-)formal on-the-job training provided within organisations or to the manifold forms of learning in informal and incidental contexts at the workplace (Cheetham & Chivers, 2001). In the literature the discussion of learning in the workplace has been developed across different and conflicting paradigms and research communities as follows:

Individualised and/or Cognitive Perspectives

In many of the earlier theoretical approaches to learning in work contexts, behaviourist and cognitive views with a particular focus on reflection and experience prevailed. These were centred on the learning of individuals, marginalising the importance of social, organisational and cultural factors in the workplace.

Schön, for example, contrasted positivist notions of practice (what he called "technical rationality"): he introduced the concepts of reflection-in-action and reflection-on-action (Schön, 1983, 1987), pointing out the meaning of reflection for the activities and learning of (individual) practitioners. Similarly, Kolb (1984) described reflection as a core element in his well-known learning cycle, which further consists of generalisation and conceptualisation, experimentation and concrete experience. Kolb's cycle is part of experiential learning theories, which have been used to explain how practitioners learn from experience outside formal programmes. Also Collins, Brown, and Newman (1987) outline the importance of processes that experts engage in to acquire knowledge in complex and authentic situations. Combining these forms of learning with cognitive elements of schooling they introduced the concept of cognitive apprenticeship. Also in this model reflection plays a central role and is part of the proposed teaching methods which aim at supporting the learner in the acquisition of cognitive and meta-cognitive competences: modeling, coaching, scaffolding, articulation, reflection and exploration (Collins et al., 1987). Beyond the model's intended use for the redesign of schooling, cognitive apprenticeship has also been used to explain competence development in workplace contexts, for example in clinical environments (see Pimmer, 2009; Pimmer et al., 2009). To a limited extent the authors in this field consider the social context and the culture in which learning takes place, linking those concepts, for example, to the learner's access to several models of expertise-in-use against which to refine their understanding of complex skills. A comprehensive review on how (individual) professionals learn in practice is offered by Cheetham and Chivers (2001).

Participatory and Socio-Cultural Perspectives of Learning in the Workplace

Social learning theorists have criticised cognitive theories for not being able to explain learning that occurs in schools and workplaces because of their disregard for social and situational factors. According to them, learning is situated, intrinsic and evolves throughout a process of legitimate, active participation in communities of practice (see, e.g., Lave & Wenger, 1991). According to Wenger (1988, 1999) a community of practice defines itself along three dimensions:

- What it is about – its joint enterprise as understood and continually renegotiated by its members.
- How it functions – mutual engagement that bind members together into a social entity.
- What capability it has produced – the shared repertoire of communal resources (routines, sensibilities, artefacts, vocabulary, styles, etc.) that members have developed over time.

A community of practice involves much more than the technical knowledge or skill

associated with undertaking some tasks. Members are involved in a set of relationships over time (Lave & Wenger, 1991) and communities develop around things that matter to people (Wenger, 1988). For a community of practice to function it needs to generate and appropriate a shared repertoire of ideas, commitments and memories. It also needs to develop various resources such as tools, documents, routines, vocabulary and symbols that in some way carry the accumulated knowledge of the community. In other words, it involves practice – ways of doing and approaching things that are shared to some significant extent among members.

Knowing is inherent in the growth and transformation of identities and it is located in relations among practitioners, their practice, the artefacts of that practice, and the social organization ... of communities of practice. (Lave & Wenger, 1991, p. 122)

Newcomers enter a community of practitioners, and, over time, with increasing responsibility, task complexity and effort they become 'old-timers', fully participating members of the community. During this transformation not only knowledge and skills change but also the learner's identity develops further. Lave and Wenger propose that the initial participation in a culture of practice can be observation from the periphery or "legitimate peripheral participation". The participant moves from the role of observer, as learning and observation in the culture increase, to a fully functioning member.

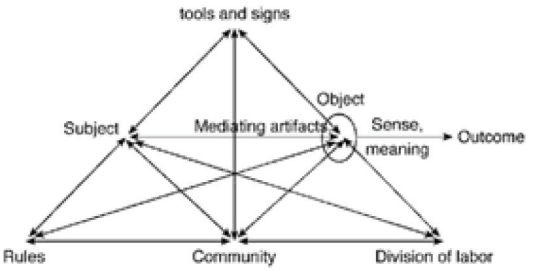
The concepts of legitimate peripheral participation and communities of practices have gained wide acceptance within workplace learning theory and research. They can be seen as a valuable complement (or counter-point) to the cognitivist and/or individualised approaches described in the previous section (see Sawchuck, 2010). However, several shortcomings have been identified – beyond the fact that Lave and Wenger's case studies mostly do not represent current workplace practices. Inter alia they do not take into account how 'old-timers', having reached full participation, further engage in learning. Research has demonstrated, for example, that experienced workers can learn through their engagement with apprentices (Fuller et al., 2005, p. 64). Moreover, no or only marginal account is taken of the role of teaching and formal education, of the issues of power and conflict, and of prior learning and experiences. It is not considered that learning may take place in several communities of practice; a fact that can be central to workplace learning (ibid).

Learning across various communities is a crucial aspect of Activity Theory (AT). There, the notion of a community of practice is replaced by the term activity system (see Figure 3), whose collective, artefact-mediated and object-orientated nature, seen in its network relations to other activity systems is regarded as the prime unit of analysis (Engeström, 2001). An activity system is a community of multiple points of view, traditions and interests and consequently, a source of trouble and innovation that gets transformed over lengthy periods of time. Historically accumulating structural tensions, for example the adoption of a new element from the outside (such as a new technology) are the reason for transformations. As the contradictions of an activity system are aggravated, individual participants begin to question and deviate from its established norms, sometimes resulting in an expansive transformation of the activity system (p. 137). Engeström (1987) considers the main differences of the activity-theoretical concept of expansive learning from traditional types of learning as follows:

The contents and outcomes of learning are not merely knowledge in texts and the heads of students but new forms of practical activity and artefacts constructed by students and teachers in the process of tackling real-life projects or problems - it is 'learning what is not yet known'.

Learning is driven by genuine developmental needs in human practices and institutions, manifested in disturbances, breakdowns, prob-

Figure 3. Engeström's activity system



lems, and episodes of questioning the existing practice.

Learning proceeds through complex cycles of learning actions in which new objects and motives are created and implemented, opening up wider possibilities for participants involved in that activity.

The activity system described by Engeström (1987) and the concept of expansive learning (2001) are popular in workplace learning research and theory (Lee et al., 2004). However, Engeström has been criticized for not dealing with the issues of power and for "not taking into account organisational environments and work contexts, and especially the processes and impact of top-down decisions, many of which are often made in response to external influences" (Fuller & Unwin, 2004a). As other researchers have shown, aspects of hierarchy and power are crucial when it comes to learning in the workplace (Ashton, 2004; Billett, 2002).

Tacit and Explicit Knowledge, Formal and Informal Learning

Much of the most interesting research in this area has taken place in the field of organisational learning, in attempts to explain how personal knowledge and skills become shared in communities of practice or within organisations and how new knowledge is developed. Research has, for example, focused on different forms of knowledge and how such knowledge is acquired and applied. Polyani has pointed to the importance of tacit knowledge stating: "we can know more than we can tell" (Polyani, 1967, p. 4). Enkenburg (1994) states that the curriculum has been based on a knowledge hierarchy of basic science, followed by applied science and then the technical skills of day to day practice (ibid.). Enkenburg stresses the importance of learning being 'situated' — knowledge cannot be separated from its source and context or environment. Knowledge is relative and learning occurs through a process of enculturation as concepts are understood through use. Knowledge is most powerfully adapted in authentic an activity, that is if it is 'coherent, meaningful and purposeful within the social framework' (Polanyi, 1958). Nonaka and Konno (1998) described with their knowledge development cycle the dynamic interaction of explicit and tacit workplace learning across multiple places. These ideas have been further developed by Dugoid and Brown (2001), Ellstrom (2001) and others.

In the field of workplace learning the concepts of formal, informal, or non-formal learning (see for example Eraut, 2000) have been widely and controversially discussed. More traditional approaches focus mostly on learning in formal, educational settings. This notion has been rejected by others such as Lave and Wenger, who pointed to the importance of learning in more informal contexts such as a community of practice (Lave & Wenger, 1991). It has been suggested that learning in informal work settings is more useful, memorable and

sustainable due to its meaning and relevancy for business needs than learning in formal classroom settings (Kersch & Evans, 2006). However, also learning in more formal contexts, such as teaching and learning in off-the-job settings, forms an integral part of learning within a community of practice (Fuller et al., 2005). Consequently, no form should be played off against the other. Other researchers have pointed to how work process knowledge is developed in communities of practice through application in the workplace (Fischer, 1996; Boreham, Samurcay, & Fischer, 2002). This work is useful in that it moves away from formally acquired and sequenced learning and towards understanding that there are different types of knowledge and that knowledge can be developed in different contexts. Similarly, it has been suggested that the distinction between formal and informal learning is problematic as all learning – regardless of where it happens – has both formal and informal characteristics (Colley et al., 2002; Billett, 2002). Pachler, Bachmair and Cook (2010) wonder whether the conceptual division between 'formal' and 'informal' learning is very helpful as it suggests differences in the processes attendant to learning where, in their view, the differences pertain mostly to the sites of learning. According to Billet (2002) and others, the discussion should be moved away from these notions, focussing instead on the structures, goals, norms, practices, agency and context.

Learning in Context: Between Practices, Structures and Agency

The current discussion in the field of workplace and work-based learning is very much centred on the notions of pedagogical and participatory practices, the (wider) organisational context and structures as well as agency: it has been widely discussed how pedagogical, participatory and daily workplace *practices* can contribute to learning. However, it has been stressed that learning and teaching at work are not solely a matter of these practices, a phenomenon flowing free of context and organisational structures: learning practices such as the mutual support from colleagues, are seen as strongly facilitated or impeded by a range of internal organisational structures such as hierarchy and power relations; even the wider economic context such as products and markets impacts on learning practices. Practices and structures can shape individuals' learning only to a certain extent: many authors have pointed out how individual characteristics and biographies relate to individual forms of learning at work. Attwell (2007), for example, noted that, although some informal learning in the workplace is motivated by organisational needs or work-based problems, much learning is driven by personal interest.

In the next sections we will show recent and current theoretical approaches and empirical findings that are strongly based on the notions of practices, structures and contextual issues and agency.

Practices

Particularly the notion of participatory practices seems to be central in the literature: participatory practices describe how individuals participate in work. The participation in practices is seen as analogous to learning in the workplace (Lave & Wenger, 1991). Lave notes (1996) that, whenever one examines practice, one identifies learning. Workplaces as "historically, culturally, and situationally-shaped environments" (Billett, 2004, p. 1) and practices that shape the individual's participation are central to understanding learning at work. In this way, "the workplace's norms and values provide opportunities for participation and, therefore, opportunities to learn" (Billet, 2002, p. 63). Unwin et al. (2007, p. 334) consider pedagogical practices such as "instruction, coaching, mentoring, assessment and feedback in the learning process" as subjects of research across a range of disciplinary fields. A survey of 1943 employees, for example, revealed the importance of workplace activities (practices), including interaction with, and mutual support from colleagues, being shown different approaches and doing the job, engaging in self-reflection and keeping one's eyes and ears open for the enhancement of work

performance (Felstead et al., 2007). Fuller and Unwin (2003, 2008) describe a framework of an 'expansive/restrictive continuum' that is based upon 'practices' rather than modelled on 'structures' (Lee et al., 2004). An expansive learning environment includes the institutional recognition and support for the status as learner, the participation in multiple communities of practices, a gradual transition to full participation, career progression after apprenticeship and access to a range of 'on-and off-the-job' learning including knowledge-based and competence-based qualifications. They see learning shaped through a complex interplay between different forms of participation, organisational structures and workplace contexts.

Structures and Context

Beside isolated contributions the wider institutional contexts which shape the learning experiences of these communities have been neglected until recently (Ashton, 2004).

Authors such as Billett (2002) or Ashton (2004) pointed to organisational structure and context as significant factors influencing learning in the workplace (Lee et al., 2004).

It has been stressed that the structuring of workplace learning experiences is not benign: learning opportunities are unequally distributed and contested (Billett, 2004). Thus, learning at work has to be particularly explored within the context of power relations (Rainbird et al., 2004). The impact of organisational structure and power on learning was also shown in a case study in a major multinational corporation on the basis of four criteria (Ashton, 2004): the *distribution of knowledge and information* of the staff was clearly differentiated according to their position in the hierarchy. Senior managers, for example, had much better access than their subordinates. Beyond these formal restrictions sometimes additional informal barriers were imposed by line managers in order to protect their hierarchical position. This tendency might have been particularly visible due to a change project that coincided with the research: superiors were reluctant to transmit information because they were afraid of losing their jobs. Another less formal learning opportunity was the access to networks which was also easier at the higher levels of the hierarchy. There was also a clear impact of organisational structure on *opportunities to practise* skills according to hierarchy. This included, for example, well-defined career lines for higher management and ad-hoc movement from one job to another for junior staff without the opportunity for the progressive building of skills over time. The availability of the *support for learning* was also strongly determined by the hierarchy of the organisation: senior staff had extensive support for learning from their peers and the HR department while junior staff were dependent on the skills and abilities of their managers and on the quality of their relationships with them. Also the form of *rewards* depended strongly on organisational hierarchy. Senior staff received increases in salary and moved up the internal career path through their learning. The internal progression of junior staff was weaker and was more dependent on their immediate supervisor's awareness of their performance.

Attwell (2007) argued that the likelihood of using technology for informal learning depended not just on access to computers and the internet (which was more often available to senior staff) but also on the opportunities to use that learning in work processes. Senior staffs (and those that had been longer in their post) were more likely to be afforded such opportunities.

Today there is much awareness of the contextual factors: in line with previous publications Unwin et al. (2007) argue that learning (and teaching) at work is not only a matter of (pedagogical) practices (and agency) that float free of context: it is, on the contrary, a phenomenon that is strongly impacted on by – what they describe as "contextual factors" that can facilitate or impede learning: based on case studies in hairdressing and automotive component manufacturing industries they illustrate how those factors can structure learning. In one example, they point out that employees in certain jobs felt much less likely to enhance

their work performance through interactions with colleagues, clients and the job itself because their work-processes were "tightly bounded and heavily prescribed" (Unwin et al., 2007, p. 337). Connecting the literatures on workplace learning, the organisation of work and performance they extended their concepts of *expansive/restrictive continuum* (ibid). They see a "Russian doll-like composition of workplaces". Beyond company internal structures (such as the organisation of work, level of employee involvement, organisational performance) there are a number of external contextual factors (such as the broader economic, regulatory, and social context) that impact on the company and the learning practices: concrete examples include the nature of their product market and ownership, regulatory requirements set by government, the price and availability of raw materials. They stress the importance of the understanding of the role and of the function of the various layers in a holistic way, but not in the sense that the tiny baby at the core is the answer to the questions (ibid).

A Fresh Approach to Learning in Context was also Developed by Evans et al (forthcoming). While the authors consider the workplace as an important starting point for analytical perspectives on work-based learning, they also recognise the need to take the social and organizational context of work and learning more fully into account. Instead of the transfer of knowledge from one setting to another they see the concept of recontextualisation at the heart of work-based learning: putting different kinds of knowledge to work in different ways according to context. The authors stress the importance of the understanding of how different forms of knowledge are 're-contextualised' as people move between sites of learning and practice in work, education and community settings. They distinguish four modes of recontextualisation (content, pedagogic, workplace and learner) that "focus on processes involved in successfully moving knowledge between disciplines and workplaces via pedagogic strategies and through learner/employee engagement". Moving beyond different types of knowledge towards strategies of putting knowledge to work, the concept of recontextualisation allows, inter alia, the identification of how "new knowledge" changes people, social practices and contexts (Evans et al., 2010). Their claim for an inclusive understanding of work-based learning (also see the definition above) includes the need to explore how creative, digital technologies can enhance learning. They also point to the new meanings of mobility as "the locations in which work is carried out diversify" (ibid). These topics are closely linked to issues of mobile learning that we discussed above.

It becomes evident that the terms context and structures are sometimes used interchangeable in the literature. Both concepts are applied inter alia to describe elements of the closer and wider environment that impact on learning. Structures can be considered as dynamic rather than static entities, according to the sociological approach of Giddens (1984) and not as objectively existing entities outside of patterns of interaction (Watson, 2003). They can be seen as a social process: as organisational 'structuration'. In this sense, individual engagement takes a crucial role in the construction and operationalisation of organisational structures. These structures, in turn, shape the conditions for individual engagement. Thus, organisational structures are not separate entities which solely determine individuals' learning but rather a subject of creation and re-creation through them (Lee et al., 2004). The analysis of structures requires looking at official and unofficial aspects (Watson, 2003). Watson refers to informal structures which are constructed through the interrelationships between workers within and across various occupational/professional levels within a workplace and other more formal structures (i.e., systems, policies, rules and 'top-down' decision making).

Agency

It is argued that even the most structured learning experiences can shape individuals' learning only

to a certain extent. Some authors pointed out that a working environment structured to facilitate learning will not necessarily lead to the intended learning. In turn, working environments with little learning opportunities will not be able to "prevent" learning of individuals (Lee et al., 2004). It is, consequently, not helpful to analyse learning solely on the basis of the structuring of learning experiences (Billett, 2002). Billett (2004) argues that despite the regulation of participation, decisions about engagement in work and the learning that arises through work are not determined solely by the situation but also by the "individuals' agency and intentionalities" (ibid, p. 5) that shape their engagement in work practice. Thus, he pays attention to how individuals engage with the opportunities and obstacles to learning according to workplace cliques, affiliations, gender, race, language or employment standing and status. His approach of considering both structure and agency was generally well received in the community. Billet was, however, criticised for overemphasising voluntarism and "free will": according to some commentators (ibid), he neglected the way how the individuals' agencies are themselves influenced through factors such as occupational positioning, one's position within a workplace hierarchy and also within these, one's gender and social class.

To avoid the concepts of voluntarism and determinism, Fuller and Unwin (2004b) contribute to the agency and structure debate with the terminology of a "learning territory": the range of learning opportunities that each individual will have accessed and will be able to access over time. A territory consists of different – past and current – learning "regions". The character of the learning territory influences how the learner "perceives and engages with opportunities and barriers to learning at work" (ibid, p. 133). They reported, for example, apprentices with poor *previous* learning regions (e.g., poor socio-economic backgrounds) as not being able to 'overcome the disadvantages' of the (current) restricted workplace learning environment. In this way, the current learning region was only poorly contributing to the extension of their existing learning territory (Fuller & Unwin, 2004b). Another apprentice with a broader learning territory (including good academic qualifications and social skills) was "fully aware that these could be utilized elsewhere should the opportunities provided by his employer prove too restricted" (ibid, p. 142).

In this way the authors underline the significance of individual biography in workplace learning (see also Hodkinson et al., 2004). They suggest that learning territories influence the individual engagement with the learning opportunities at work. However, they also point out how workplace environments themselves make a significant contribution to the individual's learning territory in the present and for the future.

Also Ashton (2004) paid attention to the importance of employee agency and the interpersonal relations between staff: the opportunities to practise were, for example, strongly determined by the delegation of responsibility. These varied between the managers according to their relationships with their subordinates, particularly depending on the level of trust. Having a trusting relationship with the person providing the knowledge and the guidance was a crucial part of the learning process (Ashton, 2004).

There are many publications about learner biographies such as how work experience or educational background impact on learning in workplace contexts (Evans et al., 2004) which show that employees with previous experience felt more confident within their current workplace and which describe how they use their previously acquired skills in their present workplace environments. Of importance is also the educational background: workers with "the lowest levels of educational attainment are the least likely to participate in work-related education or training" (Bates et al., 2005, p. 19). A number of further characteristics that impact on the learning such as age, gender, ethnicity, family circumstances, learners' attitudes and dispositions have been identified in the literature (compare for example Kersch & Evans, 2006, Bates et al., 2005). Bates et

al. reports, for example, that older workers are the least likely to participate in work-related training (ibid, p. 19).

Despite the creative potential and the valuable contributions of many of the stated schools of thought in their respective areas, none of the described single approaches can holistically explain the multi-dimensional phenomena of learning in work-contexts (see also Sawchuck, 2010). However, reflecting the discussion of learning in work-contexts it can be noted over time that more and more contextual factors have been taken into account. Departing from a rather narrow focus on the learning of individuals, the researchers' attention moved to socio-cultural contexts such as participatory practices. Today, there is recognition not only of agency, learning practices and the internal organisational contexts, but even the "wider canvas of political economy" (Unwin et al., 2007, p. 335) and society are taken into account. Latest publications have stressed the need to consider work-based learning in terms of ecology in order to understand the complexity of factors that impact directly and indirectly on learning without ignoring the bigger picture. In ecology individuals and groups have spaces in which to exercise agency in ways that can impact on the whole dynamic, through the interdependencies involved (Evans, forthcoming).

INTERIM CONCLUSIONS AND OUTLOOK

In mobile learning theory the focus has arguably been on moving away from a technological to a social point of view with reference to cultural-historical psychology. In particular, there has been an emphasis on structures, practices and agency within a socio-cultural ecology.

In our brief — and admittedly selective — outline of approaches to WBL with a focus on work-located concepts, we show how, over time, the attention of researchers has shifted from a narrow focus on the learning of individuals to the exploration of socio-cultural contexts with reference to organisational perspective and wider political and societal environment.

It is intriguing to note how much overlap there seems to exist across the work of researchers in these fields and how similar the key concepts as well as the theoretical and conceptual models drawn on by both fields appear to be.

Yet, key differences also emerge: terminology central to both fields is not necessarily understood in the same way as it tends to be embedded in different disciplinary discourses at different levels of maturity, for example an organisational perspective in the case of work-based learning and cultural and media studies in the case of mobile learning.

For WBML to be able to emerge as a theoretically and conceptually coherent field of inquiry in its own right, further work is needed on aligning the trajectories of research in mobile and work-based learning.

We have attempted to show in this paper that there is scope for fruitful synergies but that, at the same time, the 'cultural borrowing' across the different areas needs to be handled with caution and undertaken with great care.

Due to lack of space it has not been possible in this paper to embark on a discussion of how the two field of mobile and work-based learning might best be brought together into WBML. This is a logical next step.

In embarking on it, we argue, additional conceptual, theoretical and practical ground needs to be covered, which it was also not possible to do here. We are, for example, acutely aware that there exists a long tradition of research into technology use in learning in general as well as in WBL in particular with a body of literature that needs to be taken into account and built upon when considering the introduction of mobile devices into WBL (see e.g., Kersh et al., 2009; for work-based e-learning see e.g., Tynjala & Hakkinen, 2005; for collaborative learning see e.g., Suthers, 2006, or computer mediated communication see e.g., Warschauer, 1997).

This will be the task of a future paper.

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ENDNOTES

1 See for example mlearn (http://www.mlearn2009.org), Handheld Learning (http://www.handheldlearning2008.com), WMUTE (http://www.wmute2008.org/), Mobile Learning (http://www.mobilelearning09.org), IADIS Mobile Learning (http://www.mlearning-conf.org/), ICALT (http://www.ask4research.info/icalt/2007/), IMCL (http://www.imcl-conference.org/), International Journal of Mobile Learning and Organisation (http://www.inderscience.com/browse/index.php?journalCODE=ijmlo).

2 Mobile Learning: A Handbook for Educators and Trainers (2005), Innovative Mobile Learning: Techniques and Technologies (2009), Literature Review in Mobile Technologies and Learning (2005), Looking Toward the Future of Technology Enhanced Education: Ubiquitous Learning and the Digital Native (2009).

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Mobile learning in resource-constrained environments. A case study of medical education.

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ABSTRACT

Background: The achievement of the millennium development goals may be facilitated by the use of information and communication technology in medical and health education.
Aims: This study intended to explore the use and impact of educational technology in medical education in resource-constrained environments.
Methods: A multiple case study was conducted in two Nepalese teaching hospitals. The data were analysed using activity theory as an analytical basis.
Results: There was little evidence for formal e-learning, but the findings indicate that students and residents adopted mobile technologies, such as mobile phones and small laptops, as cultural tools for surprisingly rich "informal" learning in a very short time. These tools allowed learners to enhance (a) situated learning, by immediately connecting virtual information sources to their situated experiences; (b) cross-contextual learning by documenting situated experiences in the form of images and videos ─ and re-using the material for later reflection and discussion; and (c) engagement with educational content in social network communities.
Conclusion: By placing the students and residents at the centre of the new learning activities, this development has begun to affect the overall educational system. Leveraging these tools is closely linked to the development of broad media literacy, including awareness of ethical and privacy issues.

1 Introduction

The potential and role of technology-enhanced learning for under and postgraduate medical education has been thoroughly explored in Western countries, which consider it an equally effective and useful supplement to traditional methods (Cook et al., 2008, Harden, 2006, Wutoh et al., 2004). Increasing attention is paid to the role of mobile learning for educating medical students and health professionals (Irby, 2011, Coulby et al., 2009, Sandars et al., 2007). In "developing countries", even greater expectations are attached to information and communication technology (ICT), particularly with respect to education and health (The World Bank, 2011, Chandrasekhar and Ghosh, 2001). The latter has a pivotal role in the context of the UN millennium development goals, where three out of eight goals are directly related to health (UN website). Inadequately skilled health staff is seen as a typical system constraint that negatively impacts the achievement of these targets (Travis et al., 2004). Technology plays a crucial role in improving the education and practice of health workers in developing countries (Pakenham-Walsh et al., 1997). In these contexts, information and communication technologies (ICT) can enable students and professionals to access up-to-date information and learning materials (Jadoon et al., 2011, Katikireddi, 2004), and these individuals may, in turn, reach a much larger group of “final beneficiaries” (Chandrasekhar and Ghosh, 2001). Currently, the evidence appears to suggest potential rather than achievement. In fact, the use of information technology in developing countries seems to be poorly integrated within formal learning curricula (Kommalage and Gunawardena, 2008). Attempts to harness ICT are troubled by a number of factors, such as a lack of media literacy (Samuel et al., 2004, Khalid, 2009, Ajuwon, 2003) and the lack of an adequate ICT infrastructure (Williams et al., 2010, Chandrasekhar and Ghosh, 2001, Kommalage and Gunawardena, 2008). Little is known about how learners can effectively use technology to support their learning in "resource-limited" settings and how this affects medical education in developing countries.

2 Material and methods

2.1 Theoretical approach and research question

Cultural-historical activity theory allows the analysis of changing systems and the learning associated with them. Accordingly, this approach can be considered appropriate for addressing the questions indicated above. In the field of education, this theory is, inter alia, widely used in studies on technology-enhanced learning and ICT use (Nardi, 1996a, Kuutti, 1996, Isssroff and Scanlon, 2002, Jonassen and Rohrer-Murphy, 1999, Sharples et al., 2007, Blin and Munro, 2008) and has been applied in medical education (Varpio et al., 2008, Brown, 2010, Wearn et al., 2008). The central construct of the theory is an 'activity' that involves subjects (e.g., medical students) who engage in actions by using tools (e.g., a stethoscope) to achieve specific objectives (e.g., provide good patient care) (Leont'ev, 1974). Individuals do not act in isolation; they are members of one or more communities (e.g., clinical teams) that are organised by a particular division of labour (e.g., what is done by the student), and their actions are shaped by explicit and tacit rules (e.g., when it is appropriate to use a stethoscope) (Engeström, 1987, Engeström, 2001, Varpio et al., 2008).

[Insert Figure 1 Depiction of an activity system. Adapted from Engeström (1987)]

Activity systems (AS) are open and unstable systems in which contradictions (i.e., historically accumulating structural tensions) are sources of conflict that also result in innovative changes in activities and learning. Contradictions can be caused by the adoption of an external element (e.g., a new technology) that collides with existing elements, such as rules and divisions of labour (Engeström, 2001). In view of this theoretical basis and in an attempt to address gaps in the literature, we have identified the following research questions:

- RQ1: To what extent does the adoption of tools (in the form of new ICT) lead to new and adapted learning activities of undergraduate students and residents in resource-constrained environments?
- RQ2: To what extent does the adoption of tools (in the form of new ICT) lead to contradictions and changes of rules, communities and division of labour in the respective activity systems?

2.2 Setting, sampling and data collection

This study was part of a larger research project exploring the role of ICT in the context of medical education in developing countries. The example of Nepalese medical education was used as a case environment with Hindu and Buddhist roots in one of the world's poorest countries (Human Development Report, 2011). Two researchers interviewed a purposive sample (Patton, 2002) of students, postgraduates, teachers and faculty members from a public and a private university to account for varying perspectives based on age, role and socio-economic and organisational background. Focus groups were chosen as a primary method because they are effective in capturing changes in the context of medical education (Barbour, 2005). In April 2011, after consent was obtained from the institutions, we presented the research process and goals to interested students and teachers at each university and invited them to participate in focus groups. We subsequently conducted eight focus groups of four to eight participants each (n=43), lasting from 57 to 93 minutes (see table

1). Anonymity and confidentiality were ensured. All students agreed to be interviewed before the discussion, and all participants allowed the conversations to be audio-taped. The semi-structured interview guide focused on the use of ICT by undergraduate and postgraduate students for medical learning, working and leisure time use and, more generally, on medical education in the respective cultural contexts. The guide was constructed based on preliminary, Skype-based one-on-one interviews with four students from each university held five months prior to the on-site visit. The discussion of themes that emerged during the focus groups was explicitly encouraged. The focus groups were conducted in English, the working language in Nepalese medical education. The researchers CP and SL alternated as interviewers and observers, making notes during the interviews and site observations.

No	Institution	Degree
01	University A	Undergraduate students
02		Undergraduate students
03		Postgraduate students
04	University B	Undergraduate students
05		Undergraduate students
06		Postgraduate students
07	University A and University B	Teachers/faculty
08	University A and University B	Teachers/faculty

Table 1 Description of sample characteristics

2.3 Data analysis

The interviews were audio-recorded, transcribed verbatim and entered with the field notes into the qualitative data analysis software *NVivo8* (Lewins and Silver, 2009). Data analysis was guided by deductive principles of qualitative content analysis (Mayring, 2004). Taking the adoption of new ICT tools in the form of new and emerging "activities" as a starting point, the other affected elements and the resulting tensions, contradictions and changes in the AS were used as an analytical basis. Two of the researchers, CP and SL, jointly coded 75% of the interviews. The rest of the material was coded by CP. The findings were discussed with all authors until consensus was reached. These discussions and the member checking, in which all participants were invited to comment on the findings (Giacomini and Cook, 2000), were integrated into the final version of the study.

2.4 Ethics

Because no formal framework was available for ethical approval, consideration of ethical issues was provided by an expert outside of the research group who was part of a Swiss ethical review board. In his expert opinion, our work did not contravene the Declaration of Helsinki. However, he identified issues related to *Ethical Legal and Social Issues* (ELSI), such as quotations in which participants reported documenting and re-using patient-related data through private technologies. The expert

emphasised that anonymity must be ensured so that no plausible harm to the interviewed groups/participants could arise from the study. He suggested concrete measures to make it impossible even for persons involved in the research project (other than the interviewers) to link any statement to specific individuals or groups. Accordingly, information such as the organisation, group size and dates of the focus groups, which was originally included, was removed from table 1.

3 Results

Due to the similarity in the Activity Systems (AS) of undergraduate and postgraduate students (both groups take exams and work in patient care), we summarise the results of the two systems in the following section. Variations that result from the stronger focus of postgraduates on patient care will be explicitly indicated.

3.1 RQ1: New and adapted tool-mediated activities

In this section, we address the question to what extent the adoption of tools, in the form of new ICT, led to new and adapted learning activities of undergraduate students and residents in resource-constrained environments. In the settings we observed, we found little evidence for systematic and "formal" forms of e-learning and e-teaching, except for the use of electronic presentation slides in the classroom. The analysis yielded, however, three new and emergent learning activities that were based on the rapid adoption of mobile devices, in the form of mobile phones and small laptops, within a time frame of only three to five years; activities that will be reported in the following three sections. In general, ownership and use of mobile phones and internet was reported to be a very broad and frequent phenomenon:

- *Interviewer: Are there many mobile [phone] users?*
- *Interviewee: Everyone has a mobile.*
- *Interviewer: Do they use it for the internet as well?*
- *Interviewee: Yes. Almost everyone is using it.*
  (Focus group 01, the number is cross-referenced with table 1)

Search for ad-hoc information

All students, particularly undergraduates, intensively used their mobile devices to spontaneously search for information. They reported that they tended to look up information ad-hoc, mostly using Google, when they encountered situations in which they did not understand terms or concepts. The interviewees reported accessing information in situ as needed in hospitals to understand a particular case or when they were studying for exams and were unable to find relevant information in their textbooks. In this sense, mobile devices supported learning and sense-making that arose within the immediacy of a situation by linking codified knowledge to situated cognition.

- *I went to the hospital and there was one lady who was diagnosed with […] and I didn't know what it was. So I looked it up what it was and there was a nice picture. (02)*
- *If we are confused we just take it [mobile phone] and look on the internet. […] we are in the hospital, walking around. (02)*
- *I use it during my postings when I want to look into a topic when I don't have access to books. When I am in the OP for example I don't have the book so I go to the mobile.*

And other times when I'm in the library and read the book but need a picture of a certain topic so I look for the topic. (01)

A few years ago, the only information sources available to students consisted of a limited number of books and teachers. At the time of this study, students reported accessing a variety of additional, current, in-depth sources in a more immediate and "situated" way, which they deemed central to their learning.

Documentation and sharing of images and videos

In clinical environments, many of the undergraduates used their mobiles to take photographs and record videos of special cases, procedures or instruments, such as in the operating theatre or in the dissection room.

- *The teacher would show an instrument and we will be asked about this in the exam so we will take a picture. (04)*
- *[I take pictures] for cases that are difficult to see that's for future purpose and learning purpose.* (04)

This method allowed students to capture their situated experiences in the hospital or lecture halls and carry them to other learning contexts. They re-used the multimedia materials at later points in time for personal study purposes, to prepare for their exams, or to share and discuss their experiences with colleagues in other social and physical contexts.

- *"If we have a photo everyone copies." (01). All of us share it to one another. (06)*
- *Because I can see the same case again and again […] I will see that again and again. (04)*

While both postgraduate and undergraduate students shared these materials with their colleagues in informal contexts, postgraduates also integrated them into their regular presentations to faculty.

Educational engagement in social network sites

An intriguing finding was the crucial role of the social networking portal Facebook in the life of nearly all interviewed students. Students most often accessed Facebook by means of their mobile phones and used it for both entertainment and other non-academic purposes. However, a reasonable number of students, residents and even some teachers in all of the focus groups also indicated using Facebook for educational purposes, mostly by means of specific sites about medical and clinical topics. These sites were used by a large number of international users, particularly from developing countries.

- *"Medical profession, I love it." That's a [Facebook] group. I'm part of the group.[…] He [the group convenor] asks questions to medical students and gives the correct answers. […] there are more than 15000 people. (03)*

By participating in these communities, students engaged in different forms of learning and interacting, including discussions of multiple- and single-choice questions and multimedia-enhanced cases. Students indicated that these "*pictures and questions"* (03) were relevant to their learning.

- *It's very beneficial. We can know many things from it. […] There are so many things we don't know from the textbooks. […] Even some simple things. While reading Facebook, it's important and you need to remember it. (05)*
- *I get used to the clinical questions and some points to learn. When I miss something in my studies we get that point as well. (05)*

3.2 RQ2: Changes of rules, communities and division of labour

In the following sections, we address the research question how the adoption of tools (in the form of new ICT) led to contradictions and changes of (a) rules/regulations, (b) communities and (c) division of labour in the respective activity systems.

Altered rules, regulations and cultural norms

The data support the view that the adoption of new ICT tools has led to aggravated tensions and contradictions, as well as conflicts with existing elements, such as rules or regulations. This holds true, for example, among students who were criticised by their teachers for their 'copy and paste mentality' and for their non-reflective and uncritical use of internet content.

- *They don't read the textbooks; they search the internet instead. […]. They don't know the basics […]. Sometimes erroneous things are given. It's not like the textbooks or authentic journals. We tell them not to totally rely on the internet but to first read the textbooks. (07)*
- *They are not using their brain. […] They just copy paste. They don't know the meaning. (08)*

  Tensions were also evident in the form of activities that students attempted to hide and did not perform in front of their teachers:
- *We do it in front of the patients but not in front of the teachers […]. Most of the teachers don't like using mobiles. […] It's not a rule but they don't like it. (05)*

In one of the institutions observed, access to social network sites and other "non-educational sites" was banned during lecture time. These kinds of tensions also resulted in rules that changed over time. For example, undergraduates reported that the use of mobile devices was completely banned in their classes: "*We weren't allowed in our times […] to take pictures or videos*". (05) However, students in the following year of the same focus group indicated that they used their mobiles in all subjects to document relevant artefacts after class: "*While teaching, we are not allowed, but after the class, we can go and take pictures.*" *(05)*

Changes and extension of communities

The adoption of ICT has led to changing practices within existing communities, such as when students communicated with their peers on social networking sites and extended their offline communities, or when they shared images and videos via their mobiles in ways that were not previously possible. The students explained, for example, how they exchanged multimedia materials in their communities and stressed the importance of these materials for themselves and their friends.

- *[We show the picture] to flat mates. "This is the case I have seen." […] The whole batch gets it. […] We proudly show it to the others. (04)*

ICT, in general, and Facebook sites, in particular, also allowed the learners to access new social communities, beyond local borders, that were not linked to existing offline communities. Some of the participants indicated that they participated in international medical groups, and some of them reported using Facebook to prepare themselves for postgraduate career opportunities abroad.

Division of labour: towards learner-centeredness

Contradictions in the AS have also resulted in an "altered division of labour". Although teacher-oriented education (still) characterised formal educational contexts, the learners were at the centre of the new and emerging activities. In contrast to the previously mentioned statements made by teachers about students' uncritical and non-reflective use of ICT, the teachers also acknowledged positive changes with respect to the "division of labour", as indicated in the following statement by a teacher:

- *There has been a dramatic change. We don't have to teach everything now. It's not teacher based learning. It is student based learning. We just tell them and guide them. We give them topics. We tell them to look up and search those topics on the internet and we ask them to verify them from the textbooks. If they find something new and interesting they can ask us. The students are helping us. They are stimulating us to study more. It's a two-way conversation. And the students are also contributing. (08)*

Changes were not restricted to one or more communities within an AS; they also played out across different systems and altered the distribution of knowledge between students, residents and teachers. For example, transformations in the AS of undergraduates impacted the "knowledge gap" between postgraduate and undergraduate students.

- *These days internet is available and even bachelor students are interested. They come with the latest information even before us. (03)*

The use of internet technologies by postgraduates, in turn, has affected the behaviour (or activities in the AS) of teachers and faculty members, as illustrated in the following statement:

- *So it [the teaching] is more based on our own experience and the textbooks that we follow. But the postgraduates have been used to the internet research from the start. The teachers have to follow the same way. There's no way out. (07)*

Mobile phone-based internet access was in particular crucial for students. While teachers and faculty also used their mobiles, they preferred to access the internet by means of their laptops.

[Insert Figure 2 AS regarding the adoption of ICT as tools for learning in medical education in developing countries]

4 Discussion

4.1 Situated, cross-contextual learning and educational engagement on social network sites in informal learning contexts

The fact that we found hardly any evidence for "formal" e-learning in the case context is not atypical for (medical) education in developing countries, where the use of such educational practices is troubled by inadequate infrastructure and a lack of media literacy. In this light, it was even more surprising to observe to what extent, at what scale and how quickly learners have adopted electronic mobile devices, such as mobile phones and small laptops, as new cultural tools, and how they have appropriated these devices for educational purposes in informal learning contexts. The research yielded three tool-mediated "activities" (or, as we would prefer, "practices") that enhanced students' situated and cross-contextual learning and professional participation in ways that were not previously possible.

By using mobiles to search for ad-hoc information, students supported the "situated" learning experiences that arose within the immediacy of a given situation, such as during the treatment of patients. In this sense, mobile devices facilitated interaction and sense-making between individuals and their environments in the "*flux of on-going activities*" (Nardi, 1996b). These tools encouraged the students' learning not only in, but also beyond and across individual situations. The ability to capture audio and video materials enabled learners to document and share their "situated" experiences and enhanced their learning “across multiple contexts” (Sharples et al., 2007), such as lecture halls, hospitals, hostels and homes. In this sense, the tools supported the learners in accumulating (learning) experiences and knowledge across activities, places and times and within and across contexts marked by fluidity, instability and fragmentation (Pachler, 2009), which are typical characteristics of medical and clinical education. However, tool-mediated learning and sharing of experiences were not restricted to local contexts. Facebook, which was mostly accessed by means of mobile devices, allowed students to participate in professional communities that ranged far beyond regional borders. Students engaged with educational content within a community of practitioners that included medical students and professionals across developing countries.

4.2 Transformation arising from informal, learner-centred contexts

Notably, learners are at the centre of the new and emerging activities. The identified tool-mediated activities were most frequently applied in personal, informal learning contexts. These activities also affected formal learning environments through, for example, the documentation of multimedia material in lecture halls. Similarly, we have shown that transformation spread beyond single AS to mutually influence the AS of students, residents, teachers and faculty. This is consistent with studies from other areas that have reported how students and postgraduates stimulated the learning of medical teachers (Balmer et al., 2008) and caused changes in clinical cultures (Bleakley, 2002). In this sense, the adoption of new tools increased the agency of the learners— "the capacity to deal with, and to impact on socio-cultural structures and established cultural practices” (Pachler et al., 2010a). This is all the more remarkable because in the Nepalese culture teachers have a central role and students rank them much higher in the social hierarchy; for example, they "*have been «trained» not to ask questions*" (Lemone, 2005). Similarly, these findings underline that formal learning environments, such as lecture halls and teachers, are "*no longer the gatekeepers of knowledge and the personal expertise*" (Pachler et al., 2010b).

4.3 Practical considerations

We have shown how medical students in a developing country adopted mobile (internet) technologies for educational purposes in informal learning contexts in the context medical education. This engagement does not necessarily lead to better ways of learning, but it raises a number of questions in relation to what Varpio et al. called "varying levels of competence with each tool" (2008) for AS or what might be considered a broad notion of media literacy, including the access, analysis, evaluation and creation of messages (Livingstone, 2004). Ethical aspects and issues of privacy must be considered when learners share clinical experiences through social network sites or when they create content by recording images and videos in clinical settings. Such issues are by no means limited to developing countries but are also prevalent in "Western" nations (Wishart, 2009, MacDonald et al., 2010). Taking clinical images with cameras and mobile phones for learning and teaching is considered

a non-therapeutic function of clinical photography and is not directly relevant for the patient's health (Berle, 2008). Accordingly, students and medical professionals should be encouraged to obtain explicit, written consent for unidentifiable images (Bhangoo et al., 2005). In view of this widespread and frequent phenomenon, it has been recently called for the integration of a code of ethics for clinical photography in codes of practice. These codes should include methods of acquisition, storage and retrieval and should also take issues of both copyright and the use of (private) mobile phones and video cameras into account (Berle, 2008). When using information from social network sites or from the internet in general, learners should be sensitised to the evaluation of trustworthiness as well as to a critical appraisal of messages (rather than a "copy and paste" mentality). Similarly, students must be supported in their purposeful use of such resources to facilitate their learning rather than becoming distracted. This challenge is not restricted to the contexts observed in this study (Bugeja, 2006). We suggest that the new 'activities' should not be ignored or restricted in formal educational settings (as in the evidence in our case study). As emphasised by Pachler et al. (2010b), these activities must be systematically addressed, acknowledged, and aligned with formal educational contexts. As noted by Cole and Engeström, these questions must be addressed before new and emerging activities are transformed into institutionalised cultural practices with "*radically Ionger half-lives*" (Cole and Engeström, 1993). Such issues should not be addressed at the level of individual teachers; they must be part of the medical curricula at institutional and national levels.

4.4 Limitations and further research

Although we have been unable to discuss new and emerging tool-mediated practices in great detail, we were able to identify and critically discuss pivotal developments and aspects of their systemic implications in the context of medical education in developing countries. We invited interested students to participate in the focus groups. This sampling strategy might have led to bias in the data. Our research was also limited by a single period of data collection and a focus on a single cultural setting. However, there are indications in the literature that ICT supports the transformation of health systems in other geographic and cultural areas (Abdul et al., 2011). Cultural historical activity theory has served as an appropriate starting point for the focus of this analysis, but a much wider range of theoretical concepts is necessary to explain the phenomena at hand. Accordingly, we propose that further research should a) expand the geographical and cultural scope (exploration of other states or continents, such as Latin America; b) increase the methodological breadth and depth (quantitative surveys to reach more participants and participatory observations and ethnological approaches to produce more detailed analyses of the activities); c) theoretically triangulate the findings (e.g., by using theories from the field of mobile learning (Pachler et al., 2010a) and informal/non-formal learning (Eraut, 2000) or social network sites (Merchant, 2011) to enhance and broaden the theoretical basis; and d) examine changes over a longer period of time to account for long-term development.

5 Conclusion

We attempted to provide a fresh perspective on the important role of technology in informal learning contexts for medical education in developing countries. We have shown how, in a very short time, students have adopted mobile technologies, such as mobile phones and small laptops, as cultural tools for educational purposes in ways that were not previously possible. Mobile devices allow learners to enhance (a) situated learning and cognition, by immediately connecting virtual information sources to

the students' situated experiences; (b) cross-contextual learning, or learning across multiple contexts by documenting and sharing situated experiences in the form of images and videos; and (c) engagement with educational content in social network communities. By placing the students and residents at the centre of the new learning activities, this development has begun to affect the overall system of medical education in the context observed in this study. To better harness this potential, learners should be supported in their critical and reflexive use of these technologies. This is linked to the development of broad media literacy, including the evaluation and creation of content as well as the consideration of ethical and privacy issues.

6 Practice Points

- Medical students in the setting of a developing country rapidly adopt mobile internet technology for rich educational practices
- Technologies support (a) situated and (b) cross-contextual learning and (c) educational engagement on social network sites in professional communities
- Technology is predominantly used in "informal" higher education
- By placing the learners at the centre of the new mobile technology mediated activities, this development has begun to affect the overall educational system.

7 Notes on contributors

At the time of the study CP, SL and UG were members of the learning.lab/Institute for Information Systems at the University of Applied Sciences Northwestern Switzerland. AKJ was Professor of Dermatology at Nepal Medical College, and GB, Prof. emerit. and former Dean of the Medical Faculty of the University of Zürich, contributed as e-learning specialist.

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9 Declaration of Interest

The authors report no declarations of interest.

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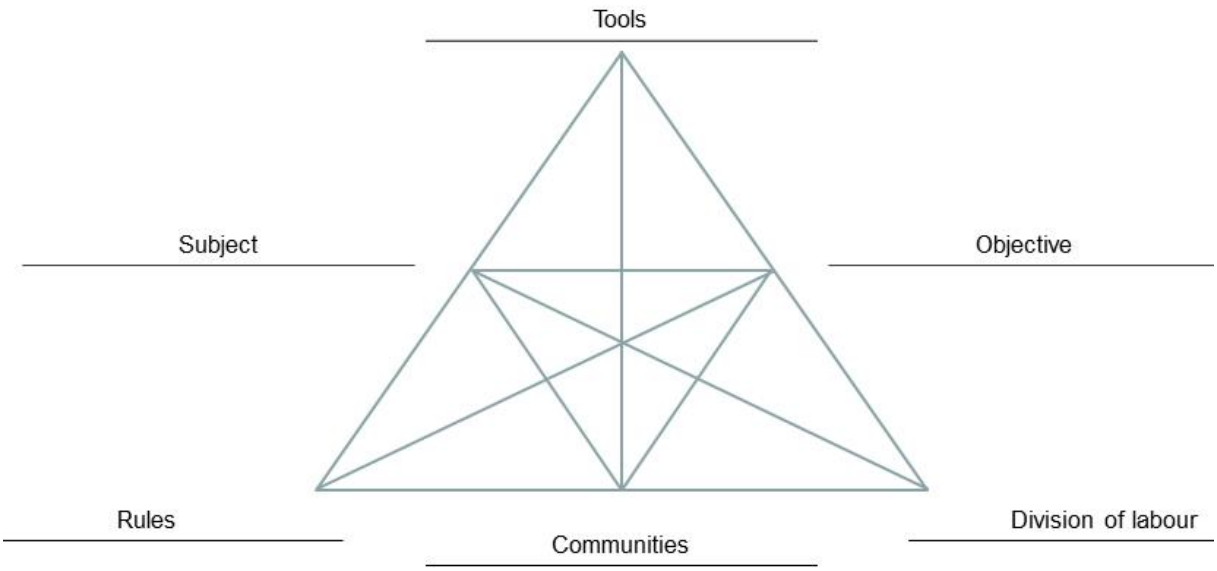

Figure 1 Depiction of an activity system. Adapted from Engeström (1987)

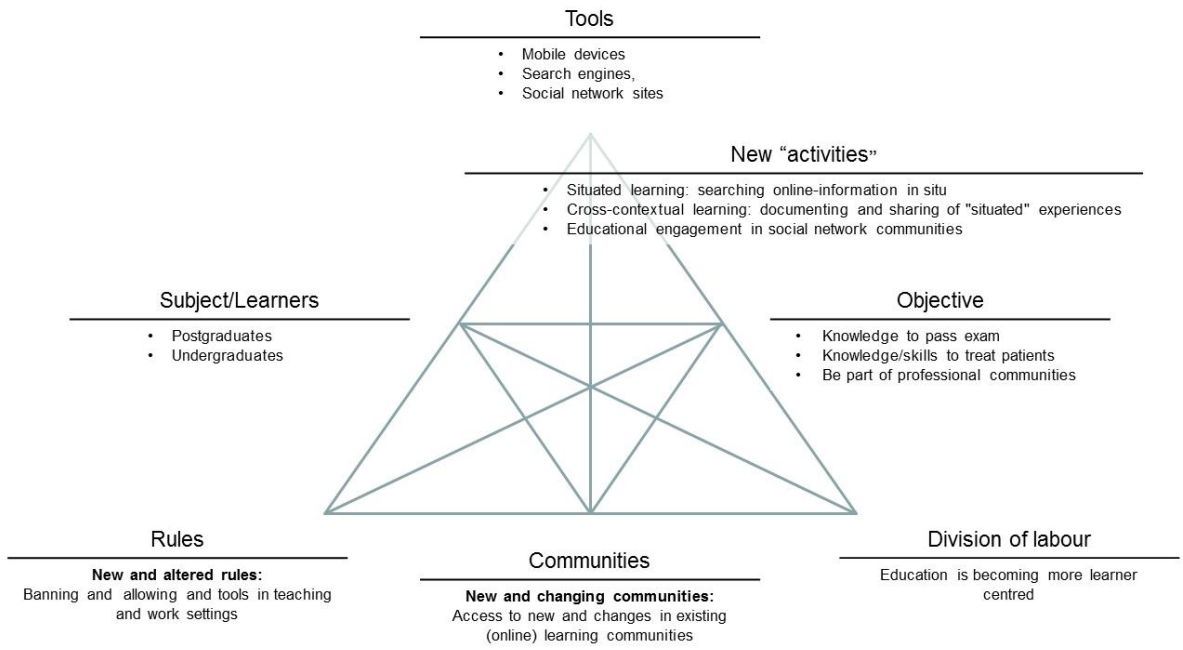

Figure 2 AS regarding the adoption of ICT as tools for learning in medical education in developing countries

11 Appendix: semi-structured interview guide

- University: practices/activities:
  - Could you describe a "normal" day/week during a semester? What are typical activities? (Where do you live? how (often) do you (and your colleagues) go to the classes?
  - Describe a "normal" lecture at the university. (Teaching methods, student participation)?
  - Are there any differences between you and your colleagues, teachers and patients due to gender, religion, social-caste or any other?
  - If you had three wishes with regard to your university: What would you change? Why?

- Learning:
  - How do you (and your colleagues) learn?
  - How do you (and your colleagues) prepare for an examination?
  - If you had three wishes with regard to your learning activities: What would you change? Why?

- Computer use:
  - How do you (and your colleagues) use computers in your daily routines? For what purposes do you use computers?
  - What kind of programs/software do you use?
  - Do you always have access to computers?
  - Do you have wireless access to the internet; for how many hours per day and at which time of the day

- Do you own a computer?
- Where do you work with computers? (Home, universities, other places). why/when not? (technical infrastructure)
- Do you feel competent in using computer and internet?
- If you had three wishes with regard to your computer use: What would you change? Why?

- Where do you have your computer skills from?
  - Did you join computer training?
  - When?
  - How many hours all together?
  - Was this training helpful for your computer skills?

- Docents/Teachers
  - Do you have non-Nepalese teachers?
  - In which disciplines?

- Practical skills:
  - Do you have patient-contacts during your study in the 1., 2., 3. and 4th year?
  - Do Nepalese patients easily allow to be investigated by students? What are particular difficulties?
  - Are there any obstacles from gender, from religion, from social-castes or any other?

- Learning material
  - Do you easily have access to learning material, like books scripts or any print material?
  - Is the material you find in your library useful to students?
  - Would you welcome tools for distant learning? Examples are live-video-transmission of lectures from India or other countries; lectures recorded on DVDs etc.?
  - Would you welcome distant learning tools from the internet?
  - Are you familiar with distant learning tools?

- Language skills
  - Do you (and your colleagues) normally use English learning material?
  - How fit do you think you are in English?
  - If you had one wish with regard to your language skills: What would you change? Why?

- Final comments
  - Have we missed anything important? Do you like to add anything?

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Facebook as a learning tool? A case study on the appropriation of social network sites from mobile phones in developing countries

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Abstract
This exploratory research investigates how students and professionals use social network sites (SNSs) in the setting of developing and emerging countries. Data collection included focus groups consisting of medical students and faculty as well as the analysis of a Facebook site centred on medical and clinical topics. The findings show how users, both students and professionals, appropriate SNSs from their mobile phones as rich educational tools in informal learning contexts. First, unlike in previous studies, the analysis revealed explicit forms of educational content embedded in informal learning contexts in Facebook. Quizzes, case presentations and associated deliberate (e-)learning practices which are typically found in (more) formal educational settings were identified. Second, from a sociocultural learning perspective, it is shown how the participation in such virtual professional communities across national boundaries permits the announcement and negotiation of *occupational* status and *professional* identities.

Introduction and background

Technologies for development and health in "resource-limited" environments

Technological innovations have given hope that new information and communication technology (ICT) tools will result in the overall progress and well-being of developing countries, in particular with respect to health and education services. Great expectations are attached to the spread of mobile communication technologies. The number of mobile cellular subscriptions worldwide is currently 4.7 billion and increasing. This includes people in remote and rural areas and "resource-limited" settings (The World Bank, 2011). To a much lesser extent there is also a discussion on affordances of social network sites (SNSs) in such contexts (Marcelo, Adejumo & Luna, 2011). Discourses and projects on ICT(4)D (information technology for development) or mHealth (mobile technology for health) tend to be based on techno-centric and deterministic approaches where learning materials, either software or hardware, are distributed by central authorities or knowledge is "delivered" according to "push-strategies"; or, using the words of Traxler, information is pumped through the infrastructure, often in "educationally naïve" ways (Traxler, in press). Similarly, the main direction of techno-centric and transmissional approaches appears to be from developed to "developing" countries respectively from experts to novices. In spite of all efforts the situation is still problematic, and ambitious visions have been only realised

Practitioner Notes

What is already known about this topic

- Social network sites (SNSs) support education-*related* learning practices.

What this paper adds

- Learners appropriate SNSs sites from their mobiles as tools for a wide range of educational practices in informal learning contexts in developing/emerging countries.
- The (e-)learning practices identified include deliberate engagement by users with explicit forms of educational content such as quizzes and case presentations as well as participation in virtual *professional* communities that allows for the announcement and negotiation of *occupational status* and professional identities.
- Such technologies permit the students' educational engagement beyond local communities and facilitate loose connections to professional networks.

Implications for practice and/or policy

- Overhasty claims regarding the more systematic use or the integration of such informal (e-)learning in formal educational settings to support education and health in developing countries should be avoided. Instead, more systematic research is needed.

to a limited extent. For example, the goal of providing every person worldwide with access to an informed and educated health-care provider by 2015 is unlikely to be realised. In particular, little progress has been made in meeting the information needs of frontline health-care providers and ordinary citizens in low resource settings (Smith & Koehlmoos, 2011). Very often it is basic knowledge that is needed, related for example to the treatment of childhood pneumonia or diarrhoea, which cannot be accessed by health-care providers such as family caregivers or health workers (HIFA Report, 2010).

With this research we attempt to shed light on aspects of technology use, such as engagement with SNSs and mobile phones, in the context of health education in developing countries, which, we would argue, have been widely neglected. In doing so, we hope to contribute to the academic discourses on SNSs and mobile learning. Since our approach follows the principles of case study research, the remainder of this paper is structured as follows. We continue with a brief and, admittedly, selective characterisation of two underlying academic discourses that can inform this research, namely mobile learning and research on SNSs. After presenting our methodological approach and results we discuss the findings in the light of multiple theoretical concepts and empirical studies from these fields. We conclude with some practical considerations, limitations and directions for further research.

Educational discourses on mobile learning and SNSs

In the field of mobile learning, a small, yet rapidly growing research community, recent work has considered the (educational) use of mobile phones as an appropriation of cultural resources (Pachler, Cook & Bachmair, 2010a, b). In contrast to the classical binary and quantitative model of adoption, appropriation is centred on the question of *how* people use mobile phones once they have adopted them (Wirth, Von Pape & Karnowski, 2008). Researchers define appropriation as the emerging "*processes of the internalization of the pre-given world of cultural products*" by the engagement of learners in the form of social practices with particular settings inside and outside of formal educational settings (Pachler, Bachmair & Cook, 2010a, b). While mobile learning research tend to focus on learning in schools, universities, workplaces or on life-long

learning in industrialised countries (Frohberg, Göth & Schwabe, 2009; Pachler, Pimmer & Seipold, 2011; Pimmer, Pachler & Attwell, 2010), some attention has also been paid to developing countries (see for example Traxler & Kukulska-Hulme, 2005).

Research on SNSs is becoming increasingly popular not only in industrialised nations (Boyd & Ellison, 2007) but, to a lesser extent, also in developing countries (Kolko, Rose & Johnson, 2007). Increasing importance is attached to educational aspects of SNSs (Selwyn, 2009), though there is relatively little theoretical and empirical attention paid by social researchers to the form and nature of that learning in general (Merchant, 2011). Sociocultural approaches to learning in general, and to social networks and mobile learning in particular are based on the notions of participation, belonging, communities and identity construction. It was suggested, for example, that such networks create a "*sense of place in a social world*" (Merchant, 2011) and can be considered as "*multi-audience identity production sites*" (Zhao, Grasmuck & Martin, 2008). By documenting daily episodes by means of mobiles and social networks, such tools are said to contribute to the formation of (multiple) identities related to the live-worlds of users. In this sense, learning is considered as situated meaning-making and identity formation (Pachler *et al*, 2010a, b). The influence of SNSs on practices of social communities was also discussed. An empirical study suggested, for example, that SNSs helped maintain relations as people move across different offline communities (Ellison, Steinfield & Lampe, 2007). Also in formal educational environments, when social networks were deliberately used in order to support classroom-based teaching and learning, (unintended) community building was observed (Arnold & Paulus, 2010). However, research has little to say with respect to vocational and professional aspects of the use of SNSs. One study reported that a company's internal SNS supported professionals in building stronger relations with their weak ties and in getting in touch with professionals they did not know before (DiMicco *et al*, 2008). Another study that observed the use of mobiles and social software for the compilation of e-portfolios witnessed influences on identity trajectory according to the concepts of belonging to a workplace, becoming and then being a professional (Chan, 2011).

Methods

Research approach and methods

This study was conducted as part of a broader research project that explored the role of ICTs in the context of higher education in developing countries, using the example of Nepal as one of the world's poorest nations; in position 157 out of 187 nations according to the Human Development Report (2011). During this project our attention was drawn to the meaning and role of Facebook along with mobile devices for students' private lives and for their learning. Accordingly, with this exploratory research we attempted to address the guiding question of whether and how the use of SNSs can contribute to the users' learning and competence development. In our analysis we drew from two different data sources.

First, data collection including informal talks and on-site focus groups was conducted by two of the authors, CP and SL, in April 2011. Consent was obtained from the institutions involved. Then, the researchers presented their project to interested students and teachers and invited them to take part in the interviews. Data were gained from eight focus groups of three to eight participants ($n = 43$) including 21 medical undergraduate and 9 postgraduate students as well as 13 teachers and faculty members. The student group comprised 11 females and 19 males between 21 and 33 years old (25.3 years on average). Teachers and medical staff were from the following disciplines: dermatology, physiology, surgery, psychiatry, radiology, paediatrics, anatomy and medicine. In order to make the group representative of university population, we involved participants from a private (Nepal Medical College & Teaching Hospitals) as well as from a public university (The Institute of Medicine/Tribhuvan University) with affordable fee structure (Bajracharya, Bhuju & Rokhrel, 2006).

The interview guide included a broad set of questions referring to the use of ICT by undergraduate and postgraduate students for medical learning, working and leisure time. The use of SNSs and mobiles for learning was not anticipated. The topic emerged in the first focus group and was then explicitly addressed in the subsequent conversations. The interviewer asked the participants about their general use of mobiles and SNSs, about associated learning practices and perceived learning effects. The interviewed persons were fluent in English, since English was the working language in Nepalese medical education.

Second, we contrasted the material with the analysis of a Facebook site centred on medical and clinical topics, namely Medical Profession, wow I Love it (http://www.facebook.com/Medicalprofession); a site which several of the interviewees along with many other users (Facebook use = 'fu') indicated that they participated in. While we were not able to track the exact behaviour of the interviewees on that site, the analysis allowed for a much broader exploration of learning and teaching practices of a large number of medical students and doctors mostly from developing countries or emerging nations.

The interviews were audio-recorded, transcribed verbatim and entered along with the field notes in the qualitative data analysis software NVivo8 (Lewins & Silver, 2009); the data of all activities of the indicated Facebook site from October to December 2012 were also downloaded and analysed:

In accordance with inductive principles of qualitative data analysis (Pope, Ziebland & Mays, 2000), one researcher read and reread the data sets to identify themes. The other researchers independently read and interpreted approximately 30% of the data. Insights and findings were jointly discussed, contrasted and interpreted until consensus was reached. The following of the identified themes were selected for further investigation: the use of (1) SNSs and (2) mobile phones as a common practice, (3) the use of explicit forms of educational content on SNSs ([a] quizzes, [b] cases, [c] instructional images and [d] videos) and (4) participation and expression of professional identities on SNSs (triggered by [a] jokes and [b] direct questions). With respect to the findings from the focus groups, respondent validation was conducted by sending an overview of the results to all participants. They confirmed the interpretation and made minor comments that did not require changes of the manuscript.

Ethical considerations

As there was no formal framework for ethical approval available, consideration of ethical issues was given by an expert outside the research group, a professor for ethics at a Swiss university who was part of a Swiss ethical review board. With respect to the perceptual data (focus groups), it was his expert opinion that our work did not contravene the Declaration of Helsinki (World Medical Association, 2012). He did, however, identify questions related to *Ethical Legal and Social Issues* such as quotations where participants reported documenting and reusing patient-related data by means of private technologies. He emphasised that anonymity must be ensured so that no plausible harm can arise from the study to the interviewed groups/participants. He suggested concrete measures to make it impossible even for persons involved in the research project (others than the interviewers) to link any statement to individuals and groups. Accordingly, information such as the organisation, group size and dates of the focus groups, which we originally included, was removed.

Upon advice from the expert we took the following approach regarding the analysis of the Facebook site. We deemed the information to be public as the site was publicly available to everyone without any restrictions. We did not consider any material from the users' personal sites such as profile information, wall sites or photo pages. Instead, we only extracted data from the site indicated. Similarly to MacDonald, Sohn and Ellis (2010) we did not participate covertly, and we did not claim to be, or attempt to become, "friends" of members of the site. In quoting text from

the site we did not disclose (user) names of individuals so as to protect confidentiality (Moreno, Fost & Christakis, 2008). Similarly, we made persons' faces unrecognisable on the photographs.

Results

First, we analyse how Facebook and mobile phones have influenced the daily routines of the interviewed students and have thereby affected their media-related practices. In the main part of the analysis we show how such technologies were used for learning purposes.

Use of Facebook and mobiles

Mobile Facebook use—a daily practice

The analysis of the interviews showed that, apart from a few exceptions, nearly all of the interviewed students used Facebook on a daily basis. In addition, Facebook was reported to be broadly accessed also by the interviewees' friends and relatives, by people across (nearly) all age groups. Most of the students use Facebook by means of their mobile phones and to a lesser extent via laptops.

> We use it [Facebook] all day from the wireless [mobiles] not from the laptops. (undergraduate students = "us")

Facebook was said to be the most intensively used tool—in comparison with other platforms and communication tools. Many of the interviewed students indicated accessing Facebook several times a day, and some even associate the use of Facebook with a state of dependency: "*All day. Every day. It's an addiction*" (us). In updating their status, uploading images and writing comments, the students used Facebook predominantly for entertainment and communication with their social environment.

Mobile Facebook as a catalyst for changing communication practices

The empirical analysis revealed the considerable extent to which Facebook use impacted on information and communication practices. Interviewees considered Facebook as a catalyst for using (mobile) Internet, and, similarly, for a radical and quick transformation of media practices. It was reported that Facebook motivated them to activate the Internet on their mobile phones. Upon activation, Facebook was deemed as one of the main reasons to access the Internet.

> The reason why most of the people have activated the internet on their SIM card is because of Facebook. (us)
> [I use the internet] every day. For Facebook, for the status. (us)

Facebook as a learning tool

During the focus groups some of the students indicated using Facebook for learning purposes. They reported accessing specific sites and groups on Facebook and engaging in discussion on medical and clinical topics.

> A group "Medical profession, I love it." That's a group. I'm part of the group. (Postgraduate students = "ps")

Medical Profession, wow I Love it is a relatively popular Facebook site. At the time of the study it saw more than a thousand interactions per week. Many of them were created by users, medical students and professionals, from developing and emerging countries such as Nepal and India. The analysis of this site revealed, amongst a few non-medical topics and non-education-centred postings, a considerable number of interesting themes that directly related to learning. In the following sections we will present and exemplify major findings from the analysis of the site and contrast them with data from the focus groups.

Explicit educational content and deliberate learning practices

Many of the site's active users used the "wall" and associated posting and commenting functions to engage in quiz questions. We identified a considerable number of postings with open and closed quiz questions from a broad spectrum of medical topics. Typically, the following course of action

Figure 1: Two forms of quiz questions on Facebook walls

was observed. A user, often the convenor of the site, posted a question. Then, other participants provided their answers in the form of comments. After a little while the initiator of the question posted the "correct" answer, also in the form of a comment. Figure 1 (left image) shows such a question that relates to a new medication for children with diarrhoea. The interviewed students described these practices in the following way:

He [convenor of the site] asks questions to medical students. [. . .] I answer by myself. [. . .] Finally he used to give the right answers. (ps)

As the analysis of the site showed, many questions received a great deal of feedback and were, accordingly, answered, commented and recommended by a large number of users. Questions where learners were uncertain about the correct answers, or questions of a high level of interest were reported being shared with other users:

If we have questions and we are not sure about the correct answers we can share it with our colleagues. (ps)

Beyond the engagement with quizzes, the site was also used for the discussion of short case presentations considered as "*interesting cases*" (ps). There, a case typically including information such as anamnesis and first diagnostic findings was briefly introduced with an invitation to post possible diagnostic and/or therapeutic decisions. Pictures were also uploaded so as to illustrate cases and quizzes (Figure 2). Again, learners posted their answers and recommendations in the form of comments. These activities were followed by the initiator posting the "correct" answer.

Interviewees did not consider quizzes and cases, which included a broad range of basic clinical knowledge, as particularly complex, "*Usually there are not tough questions*" (ps). They deemed the engagement with educational content in the form of questions and images as relevant for their learning and considered it as a learning opportunity in addition to their formal medical education or more specifically, their textbooks.

There are so many things we don't know from the textbooks. G: Even some simple things. (us)

In addition to the embedded educational content we also identified a number of links to medical information resources outside Facebook such as e-books or videos.

Sociocultural aspects: participation and expression of professional identity

In addition to explicit forms of educational content the analysis of the site also revealed a number of aspects centred on participation and professional identity, which relate to a sociocultural understanding of learning. Yet the name of the site "Medical Profession, wow I Love it" indicates a positive connotation to the medical profession. Further examples included particular questions or cartoons and jokes that related to the understandings of medical students and doctors of their own professional identities. This is exemplified, for example, by the feedback and responses provoked by the question, *"Proud to be in this profession, what about you?* This comment was posted by the convenor of the site, and received more than 60 comments and 200 "likes." In addressing the questions, users mostly showed agreement and demonstrated high professional identification and

Figure 2: Case presentation

professional membership. In doing so they also pointed to professional challenges, emphasised professional norms and professional codes of conduct, as shown in these three statements:

yesss.bt its nt be easy thre way iz vry tough whn u make a good doct. othrwise itz the best profession in the world.bt doct should be polite,gentily care and serious [. . .] (Facebook user = "fu")
i'm very proud and love this profession very much . . . though very tired and many problem we have to solve. but still. I'm proud and love it . . . (fu)

On the site observed the discussion of professional themes was not a singular phenomenon, as also alluded to by the following posting: "*how many times this question is asked on this page . . . any idea?lol.*" Similarly, cartoons and jokes provoked reflection on and engagement with the users' professional identities and their occupational self-perceptions and status. They caricatured medical disciplines or, as illustrated by Figure 3, medical doctors in general:

The comments of more than 90 users on this cartoon (Figure 3, January 11, 2012) demonstrate the high level of feedback and illustrate how medical students and professionals compared and negotiated their professional self-concept—on the basis of their professional experiences—referring to the messages from the cartoon. Some of the users fully agreed with the message of the cartoon. For example, a user appreciated the opportunity provided by professional identification and deemed it as valuable support in a difficult occupational situation "*feeling crap*." Other users only partly agree and signal differences to their own professional (self-)understanding.

sure im proud and love my work and in good relation with my patient (fu)
This pic pretty much describe my life, thanks [. . .] for making me realise I am not the only one feeling crap right now. (fu)
no life . . . i agree . . . no money i dont agree:) (fu)

Figure 3: Cartoon triggering discussion on professional identity and occupational status

Level of participation and interaction

As indicated, considerable interaction was observed on this site. Some posts received a few hundred comments and even more recommendations in the form of "like." Statistics show that since the creation of the site in May 2010 it has been recommended by more than 36 000 users and that in the last 7 days there was a total of 1750 interactions on the site (December 24, 2011). The convenor fostered participation and interaction also in the form of nominating a "fan of the week," a user who shows particular engagement with the site. As indicated, a few users, often the convenor of the site, made initial contributions, while the majority responded and provided feedback. In the same way the interviewed students perceived their role as mainly reactive, including answering and commenting on statements from others. This is interesting as, from a technical standpoint, every user was enabled to make initial contributions.

I haven't contributed to questions. I only answer questions. [. . .] I think that we are only allowed to answer. (ps)

In the interviews, younger teachers and younger faculty members also reported regularly using Facebook for professional learning purposes, and deemed the platform as an appropriate tool to share medical information with (professional) colleagues.

We share a lot of medical information on Facebook. We share videos. And sometimes some of our friends get free downloads of books. So we share that. Facebook is a good medium to share much medical information. (teacher/faculty)

This view was also confirmed by the analysis of the Facebook site, as we have already indicated that beside students, mostly medical doctors participated. We also found occasional questions by patients asking doctors for diagnostic or therapeutic advice.

Discussion

In the following sections we discuss the use of Facebook sites along with mobile phones as educational tools through different theoretical and conceptual lenses and, lastly, we conclude with some practical considerations, limitations and directions for further research.

Appropriation of Facebook and mobiles for deliberate (e-)learning practices

Drawing on the work of Merchant (2011), who distinguishes learning *about*, *from* and *with* SNSs, the way learners used technologies in the manner observed clearly relates to the last form. Empirical studies identified different forms of learning with, or, as we would prefer, "through participation in" social networks such as developing and demonstrating new literacies (Greenhow & Robelia, 2009). However, the exchange of factual and more academic forms of knowledge in informal learning contexts has been reported to a limited extent. For example, one fifth of university students, typically "newcomers," exchange information *related* to their studies by seeking contact with other students as well as orientation in their new environment (Wodzicki, Schwämmlein & Moskaliuk, 2011). In the field of medical education a study reveals that one quarter of the students used Facebook for educational reasons (Gray, Annabell & Kennedy, 2010). Another study that also reports education-related aspects in the use of SNSs by students has found factual and more academically oriented information, although to a lesser extent (Selwyn, 2009). Similarly, it has been observed that students' Facebook engagement were for social reasons, but not for "relatively" formal learning and teaching (Madge, Meek, Wellens & Hooley, 2009).

Surprisingly, in the site explored there is much evidence for explicit forms of educational and academic content and associated learning and teaching practices such as the engagement with quizzes, case presentations or the exchange of external multimedia learning resources via links; These are deliberate practices and explicit representations of knowledge and learning which we would typically expect in e-learning platforms or learning management systems and associate with classic approaches to (higher) education in formal learning contexts. This might to some extent confirm the findings of Gray *et al* (2010) who reports that medical students use Facebook groups to interact with university colleagues in educationally conservative ways. However, there, the students do not interact across their institutional boundaries and do not connect to more professionally oriented communities (Gray *et al*, 2010). As discussed, in the context of our on-site research as well as in developing countries in general, ICTs tend not be integrated in (medical) curricula or in teaching practices, for example, due to the limited availability of computers and Internet facilities (see for example Kommalage & Gunawardena, 2008). In view of these affordances medical students and professionals have quickly appropriated SNSs as relatively formal (e-)learning platforms in informal learning contexts in ways beyond those for which such technologies were originally designed.

Participation in professional communities and formation of professional identity

Aspects related to *expression* of *professional* identity, belonging to and participation in *professional* communities appear to be inherent parts of the site observed. We have shown how engagement and participation in such wider, virtual *professional* communities by means of mobiles allows for the announcement of *professional* identities (Zhao *et al*, 2008) and, at the same time, includes discussion and negotiation of professional identities as part of the (professional) self-concepts. Similarly to Chan (2011), who has conducted research on the use of mobiles along with e-portfolios in social network environments, we suggest that such sites can provide opportunities for expressing and negotiating individuals' professional identity. Chan also found such technologies suitable to enhance self-recognition of transformation and trajectories of vocational identities. In addition, she considers the collection of evidence by means of these tools as affordances for the research of such trajectories, and, more in general, for the exploration of situated learning. The Facebook site which we observed was, however, rather centred on the unsystematic presentation of topics than on the development of individual users and did, accordingly, not allow for the exploration of longer identity trajectories. It did, however, enable spontaneous forms of announcement, discussion and negotiation of occupational status and professional identities in

the context of a wider community of medical students and doctors across national boundaries. There, the meaning of community differs considerably from the classic notion established by Lave and Wenger (1991). While they concentrated on "real-world" communities, and only at a later point in time discussed how information technology might support existing communities (Wenger, White, Smith & Rowe, 2005), the observed SNS was mainly based on virtual relations (without an offline community) where learning and participation appeared to be far more short-lived and ephemeral; putting it in the words of Lave and Wenger (1991), most of the members would rarely move from peripheral to more central (respectively active or instructive) forms of participation. Also, participation observed on the site cannot be considered as belonging to workplaces (Chan, 2011) but rather to (other), less intense professional communities. However, we would definitely interpret the participation of learners in multiple professional communities as one characteristic of an "expansive" (and learning rich) environment (Fuller & Unwin, 2004).

Blurring educational boundaries and the redistribution of knowledge and power?

The practices observed also illustrate blurred boundaries between different cultural practices such as entertainment and learning, noted by Pachler *et al* (2010b). In the focus groups it became clear, however, that knowledge and expertise developed outside educational settings (for example on Facebook) was not taken into account in the context of formal (medical) education. Teachers and faculty did not report to integrate the Facebook activities of the students into formal learning practices, and the access to SNSs was even banned during lectures in one of the universities. During these hours students accessed Facebook mainly by means of telephone networks. In this sense, the blurring of boundaries (still) occurs in a rather unidirectional way. Our research has also shown that formal educational institutions are "*no longer the gatekeepers of* [what we would consider "formal"] knowledge" (Pachler *et al*, 2010b). We would attach even greater importance to this transformation in resource-limited settings, where access to formal forms of knowledge and learning resources has been typically restricted to teachers and (a few) books in libraries. Our data also support the view that social mobile learning practices can, according to Pachler *et al* (2010b), be characterised by distributed resources, power and practices across life-worlds and lifestyles. Practices were also distributed across local and even national contexts, as most of the participants of the observed Facebook site appeared to be located in developing and emerging countries. However, power in terms of structuring interactions on the site appeared not to be equally distributed across the users. The rather reactive behaviour of the interviewed students may reflect to a certain extent, existing cultural and educational patterns, which are characterised by a relatively large power distance in Nepal. For example, Nepali students consider teachers as higher in the hierarchy and tend not to ask questions (Lemone, 2005). This also reflects the findings of Zhao *et al* (2008) who suggested that in Facebook individuals tended to behave according to established norms.

Pedagogical, ethical and practical concerns and further research

Mobile phones and SNSs are technologies that are reaching more and more people also in developing countries. We have shown how learners in such contexts appropriate (and do not solely adopt) technologies for their learning. They take part in professional communities and access basic medical knowledge according to pull-strategies (they select when and how to engage). We have revealed interesting and, to date, to some extent underexplored aspects of technology use for (health) education in developing and emerging countries, and we hope and believe that this might also provide fresh perspectives on development approaches, which tend to distribute technology or "transmit" knowledge and thereby are inclined to neglect sociocultural characteristics.

Nevertheless, from a practical perspective, these considerations by no means permit the seemingly obvious conclusion that such technologies should be recommended without reservations or that they might even be used more broadly and systematically. On the contrary, in view of ethical, legal

and privacy issues, and against the background of a number of pedagogical limitations we deem the (systematic) use of commercially oriented software in the context of health education in developing countries as highly problematic. A critical aspect is, for example, the question of quality control. In Facebook there are no mechanisms provided that help to ensure the quality and trustworthiness of learning contents presented. Accordingly, there is, apart from critical peer feedback, no protection against problems inherent in poor or wrong advice being given and followed. And, if such educational material is simply copied from other sources (for which we found some evidence), copyright laws are likely to be violated. From a learning perspective, knowledge was presented unsystematically (compared with formal learning contexts) and was not linked to any specific curriculum or to the learners' previous knowledge. Also, we would argue that Facebook did not facilitate deep engagement of learners in the form of interactive in-depth discussions: "Walls," which were used as discussion boards, only allowed one level of interaction, ie, it was not possible to re-comment on existing comments and, accordingly, to build threads. Similarly, Friesen and Lowe (2012) argued that Facebook, as a commercial tool, does not foster disagreement and debate but produces interactivities characterised by conviviality and "liking" and is, therefore, a questionable tool for education. (There are a number of other pedagogical and ethical limitations, whose discussion would go well beyond the scope of this paper). Our analysis has also provided no solutions regarding how the "informal" practices might be aligned with learning in formal contexts. We suggest that such learning should not be ignored but explicitly addressed in the classroom and critically discussed with respect to media literacy. Both learners and teachers should be systemically supported in considering opportunities, risks and limitations. Harnessing such affordances for learning strongly depends on (the development of) broad media literacies with respect to evaluation as well as creation of content (Livingstone, 2004).

From an academic perspective, very little is yet known about the phenomena explored. For example, even if the site observed shows considerable interaction, we do not know how many Facebook users engage in educational practices. It has to be acknowledged that we only analysed one of many Facebook sites that are centred on clinical and professional topics. Examples of other sites are Faculty of Medicine an even more active community, or sites with users from special cultural and regional backgrounds like Arab Medical Doctors or Medical Jokes, a site explicitly dedicated to cartoons and jokes about the medical profession. Accordingly, future research should analyse such sites more broadly and may also consider sites centred on other professions in platforms other than Facebook. In view of the pedagogical limitations identified, we also suggest more in-depth research addressing the extent to which the engagement with such sites impacts on learning and can inform (clinical) practice. Also, the underlying motives of users, those of both learners and "teachers" on such sites should be researched. Accordingly, we are fully aware that with this research we have neither been able to explore the topic in great detail nor to provide definitive accounts of the phenomena observed. We hope, however, that we have been able to provide a rich jumping-off point for future explorations.

Conclusion

The interviewed medical students in resource-limited environments consider the use of Facebook from their mobiles as a daily and highly popular practice. Some of them also appropriate these technologies as educational tools, along with many other users, students and medical professionals, from across developing and emerging nations. The analysis of the interviews and of a Facebook site centred on medical and clinical topics revealed rich (e-)learning and (e-)teaching practices in informal learning contexts. First, unlike previous studies, we identified explicit forms of educational content such as quizzes and case presentations which were embedded in Facebook and associated with deliberate (e-)learning practices in informal learning contexts. One would

typically expect this type of learning in (more) formal educational settings. Second, from a sociocultural learning perspective, we have shown how the participation in such virtual *professional* communities across national boundaries also allows for the declaration and negotiation of professional status and professional identities. In pointing to the importance of exploration and the acknowledgement of existing "technology-enhanced learning" practices, we hope that this research might also provide fresh perspectives to development projects, which tend to disseminate technology and "push" knowledge to learners. However, research on the phenomena at hand needs to increase in both depth and breadth. It requires a number of ethical issues to be considered before any definitive accounts related to the effectiveness of such tools on health, education and development in "resource-limited" settings can be given.

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Contextual dynamics in clinical workplaces: learning from doctor–doctor consultations

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CONTEXT Some studies have explored the role of learning context in clerkships and in clinical teams. Very little is known, however, about the relationship between context and competence development in more loosely framed, day-to-day practices such as doctor–doctor consultations, although such interactions are frequent and typical in clinical work.

METHODS To address this gap in the literature, a study was conducted using semi-structured interviews in four different hospitals and participant observation at one site. Inductive content analysis was used to develop a framework. Special reference was made to the principles of situated cognition.

RESULTS The framework illustrates how different situational, personal and organisational factors interact in every learning situation. The interplay manifests in three different roles that doctors assume in highly dynamic ways: doctors learn as 'actors' (being responsible), as 'participants' (being involved) and as 'students' (being taught); contextual influences also impact on the quality of learning within these roles.

CONCLUSIONS The findings add to the current literature on clinical workplace learning and to the conceptualisation of context in the field of education. The practical contribution of the research lies in disentangling the complex dynamics of learning in clinical environments and in helping doctors and medical educators to increase their responsiveness to contextual factors.

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INTRODUCTION

We begin by briefly discussing the existing concepts and empirical findings of context, and learning in context. We make particular reference to the theory of situated cognition, which, as we argue, serves as a good starting point for understanding learning in the dynamic context of clinical workplaces. Then, we briefly introduce the doctor–doctor consultation, which represents the unit of analysis for this study and is an under-researched example of learning that occurs in loosely framed, day-to-day practices.

Notions of context and situated cognition

Although many fields, such as those of geography, architecture, anthropology, psychology and computer science, are concerned with notions of 'context', 'space', 'place', 'environment' or 'climate', in educational studies the meanings of these concepts tend to be neglected and under-theorised.[1,2] Basically, two different notions of context or climate can be found in the social science literature[3] and are reflected in the field of medical education. Some scholars consider context to be an element that surrounds learners in a manner reminiscent of a shell or container. Others argue that context is actively produced and arises from activity and interactions.[3–5]

Situated learning theories, and situated cognition, are valuable approaches that help in the study of context.[6] They support the second perspective because they shift the focus from individuals in an environment to the interactions (or processes) between individuals and their environment.[7–9] Accordingly, knowledge is not considered an element that is exclusively in the minds of people, but, rather, as 'situated, being in part a product of the activity, context, and culture in which it is developed and used'.[10] The meanings of situated learning and situated cognition were also recently stressed in the field of medical education because, it was argued, these theories would help to better explain the complexities of learning in clinical and medical contexts.[11–13]

Learning in (clinical) contexts

In medical education, it is widely acknowledged that the development of medical and clinical competences is context-dependent.[14] The term 'context', however, is inconsistently discussed.[11,13,15–17] For example, studies characterise context by physical, semantic, affective, temporal or social dimensions.[13,16] It has been suggested that a more detailed understanding of how contextual factors influence clinical workplace learning would be valuable.[18,19] Boor *et al.*[20] stress that, in particular, the interplay of factors that affect the quality of a clinical learning climate tends to be neglected.

Most studies have been conducted to investigate the learning context of students in clerkships; for their learning, the importance of an integrative, supportive and participative team culture in clinics has been emphasised. Thus, inter alia, the learners' roles, their individuality and their work contributions must be acknowledged by other team members, and an 'environment' that allows them to progress from peripheral to more central participation, and thereby to develop professional identities, is required.[15,20–22] One study identified five influencing factors that affect the learning of undergraduate medical students in internships: the agenda of the internship; the attitude of the supervisor; the culture of the training setting; the learning attitude of the intern, and the nature of the learning process.[23]

In postgraduate medical education, studies have offered similar findings about participation in clinical activities and the provision of adequate support.[18,24] Moreover, factors such as time pressure and workload have been reported to be relevant.[25,26] Similarly, one study has described the different implications of patient census (patient illness, total number and pace), time sensitivity and conflicting commitments for learning and teaching in ward teams.[19] The authors noted that the sources (colleagues, books, etc.) consulted by learners shifted with an increasing census towards 'quick, authoritative, readily available sources'.[19]

Learning in the 'context' of doctor–doctor consultations

Very little is known, however, about the relationship between context and learning in more loosely framed, day-to-day practices such as doctor–doctor consultations, which represent interactions outside typical team structures and have no formal learning elements. In consultations, doctors refer to more experienced and specialised colleagues, typically in reference to more complex patient cases outside their competence. For instance, a doctor may involve an on-call doctor from another specialty (an expert) or, in more complex cases, if the on-call doctor is a resident (and thus acting as a learner), he or she may subsequently also refer to his or her attending physician. Although learning and education in

clinical workplaces comprise different types of informal learning, such as working with clients (patients), being mentored and working alongside peers,[27] consultations are mostly dyadic practices that involve medical actors with different areas and levels of knowledge. One-to-one interactions are, however, very typical in interprofessional clinical work. Surprisingly, they have been widely ignored in the interprofessional literature to date.[28]

METHODS

Research question, data collection and analysis

Against the background of the gaps identified in the literature, this study attempted to address the following research question: How and to what extent is clinical workplace learning influenced by contextual factors in loosely framed, day-to-day practices such as doctor–doctor consultations?

In this study, we focused on doctor–doctor consultations because they are very typical in clinical work and are rich sources of inter- and intradisciplinary learning, particularly for the residents involved.[29–32] Consultations between the emergency department (ED) and other specialist departments were chosen because of their frequency, variety and intra- and interdisciplinary nature, which allowed us to involve many disciplines in the investigation.[29–31]

Process

The research was performed in several phases (Table 1). First, a brief field study of 10 hours, including observation and informal talks, was carried out. Then, in phases 2 and 3, a total of 17 doctors in four different hospitals in Switzerland were interviewed.

By following purposeful and typical sampling strategies,[33] we involved a wide range of participants, including those with roles typically represented in consultations in smaller as well as larger hospitals.[33] (Table 2 and Appendix 1 show the characteristics of the interview sample.) Eventually, participant observation was conducted at one site (see Table 2). Data collection was concluded upon reaching theoretical saturation.[34]

Interviews

For the individual semi-structured interviews, an initial question guide was prepared and iteratively developed.[35] The interviews, which lasted for 30–100 minutes, were centred on participants' personal experiences and perspectives of doctor–doctor consultations, including processes, roles and responsibilities, as well as other contextual influences that help or hinder learning in the context of consultations. The interviewer explicitly intended to follow themes that emerged during the interviews.[33]

Observation

During the field study, direct participant observation[33,35] was combined with the shadowing of individual doctors[36] and brief informal interviews. Observation was particularly helpful for understanding the learning processes and the associated learning roles (Fig. 1). Field notes were taken during the observations, and the data were entered into the qualitative software NVivo Version 8 (QSR International Pty Ltd, Doncaster, Vic, Australia) within 4 hours of the researcher's departure from the clinic.

Analysis and validation

Interviews were audiotaped, transcribed verbatim and then entered into NVivo 8 along with the field notes. An analysis was performed using the method of inductive category formation, a procedure of qualitative content analysis suggested by Mayring.[37] According to the research questions and to the principles of situated cognition, the level of abstrac-

Table 1 Phases and methods of data collection

Phase 1	Brief observation (total: 16 hours)	Hospital A	May–June 2010
Phase 2	Semi-structured interviews (n = 10)	Hospitals A and B	January–March 2011
Phase 3	Semi-structured interviews (n = 7)	Hospitals C and D	June–July 2011
Phase 4	Participant observation (total: 60 hours)	Hospital A	February–April 2012

A = university hospital; B = cantonal hospital; C = regional hospital; D = university hospital

Table 2 Interview sample characteristics

	Specialty/department	**Seniority**	**Years in residency**	**Current role in consults**	**Hospital***	**Gender**
01	Hand surgery	Resident	5	On call	A	Male
02	Internal medicine, ED	Attending	N/A	Requesting	A	Male
03	Pathology, ED	Resident	N/A	Requesting	B	Male
04	Internal medicine, ED	Resident	1	Requesting	B	Female
05	Orthopaedics, hand surgery	Attending	N/A	On call	A	Male
06	Geriatric medicine, ED	Resident	3	Requesting	A	Female
07	General and hand surgery	Resident	2	On call	B	Male
08	Plastic and general surgery	Resident	3	On call	A	Male
09	Internal medicine, ED	Resident	4	Requesting	D	Male
10	General surgery	Resident	5	On call	A	Female
11	General surgery	Attending	N/A	On call	C	Male
12	Internal medicine, ED	Resident	3	Requesting	C	Male
13	Internal medicine, nephrology	Resident	4	On call	D	Female
14	Orthopaedics	Resident	6	On call	D	Male
15	Plastic surgery	Resident	6	On call	D	Male
16	Internal medicine, ED	Attending	N/A	Requesting	D	Female
17	Infectology	Resident	7	On call	D	Female

* A = university hospital; B = cantonal hospital; C = regional hospital; D = university hospital
ED = Emergency Department; N/A = not applicable

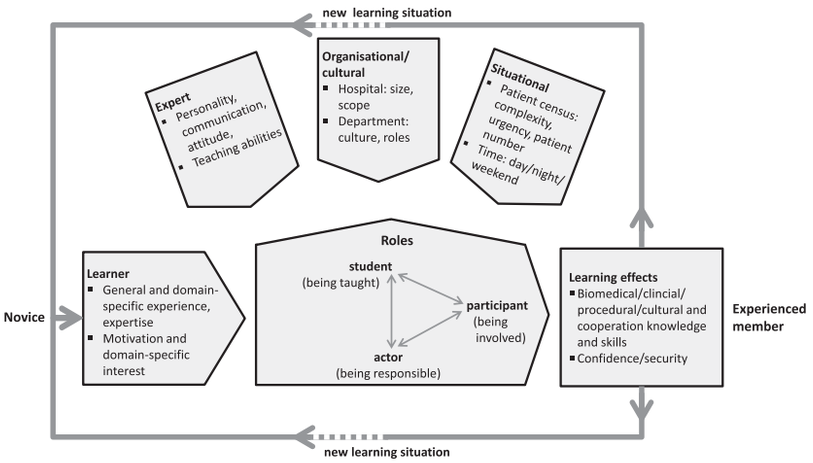

Figure 1 Learning context as the interplay among influencing factors using the example of doctor–doctor consultations

tion and selection criteria for categories were roughly defined as influencing factors and their interplay. Learning in consultations was analysed in particular from the perspectives of the residents involved. One researcher (CP) analysed all the data and iteratively developed categories. In parallel, a second researcher (NP) read, re-read and interpreted approximately 20% of the material. In collaboration with the third researcher (UG, a medical doctor and insider at clinics A and B), the coding structure and the conceptual framework that emerged from the data were iteratively developed and critically discussed

until consensus was reached. Finally, the material was re-worked by CP according to the accepted coding scheme. In order to evaluate inter-coder reliability, a fourth person, not an author, coded 20% of the material. Inter-coder reliability between the two coders was assessed using NVivo 8 functions. Upon discussing ambiguities,[38] all nodes and sources achieved agreement of > 90%. According to the principles of respondent validation, participants were invited to comment on the preliminary results. A few participants made minor suggestions that did not require changes in the framework.[39]

Ethics considerations

Ethics advice was sought from the regional ethics review board. The committee decided that on the basis of the research concept, no further ethics approval was required. In addition, ethics advice was also obtained from a specialist outside the research team, a professor of ethics at a Swiss university, who sits on a separate Swiss ethics board. The confidentiality of the participants was ensured. General agreements were made with the departments in the different hospitals and, prior to the interviews, written (informed) consent was obtained from every participant. All of the participants allowed the conversations to be tape-recorded. For field observation, an ethical code of conduct was developed with the ethics expert.

RESULTS

Before we discuss contextual influences including personal, organisational and situational factors and their implications on learning in detail, we characterise three roles that result from the interplay of these influences. (To illustrate the findings, empirical examples from the interviews and the participant observations are cross-referenced between the text and Table 2 and Appendix 1. The first part of the reference code represents the number of the extract and the second part links to the table 'interview sample characteristics'; 'PO' indicates 'participant observation'. For example, '01.08' refers to extract number 1 (Appendix 1) from participant 8 in Table 2).

Learner's roles

The doctor as actor (being responsible)

This role can be characterised by high degrees of exploratory and self-directed learning. This means that learners independently examined, evaluated and treated patients, accessed codified knowledge[18,40] and, thereby, developed their own diagnostic and therapeutic conceptions. Responsibility and pressure, which were linked to this role, were deemed to be particularly relevant to learning (01.08), given the opportunity to involve experts in instances of insecurities and questions (02.07).

The doctor as participant (being involved)

When doctors learned as 'participants', they were involved in situations with more experienced and specialised doctors (hereafter 'experts'–who may still benefit and learn from consultations). They had the opportunity to rather passively observe and listen (03.13); they could also actively take part by articulating their conceptions (they had elaborated as 'actors') and by asking focused questions (04.13).

The doctor as student (being taught)

In the role of 'student', doctors benefited from the deliberate teaching of experts in processes that went beyond the requirements of normal patient treatment. In these situations, doctors were challenged by critical questions (05.02) and were supported by demonstrations and explanations (06.06) given in order to facilitate learning.

Learner characteristics

Motivation and domain-specific interest

In general, the motivation and interest of doctors to learn in daily work situations and in consultations were deemed to be high (07.13). However, the residents were differently interested in consultations. These differences were linked to the different motivational dispositions of learners (8.04). The motivation to learn was also dependent on the degree of a case's alignment with the learner's special interests and intended specialisation (09.15). High interest and motivation were naturally tied to very positive effects on learning in all three roles; in the role of actor, motivated doctors were reported to engage more proactively in learning situations (10.PO) and to explore cases more thoroughly and were more likely to access codified knowledge (11.08).

Motivation greatly influenced the participatory role; if doctors were interested in a case, they actively attempted to participate in situations with experts (08.04, 09.15) and involved themselves by asking

questions, for example. If the learners showed interest and motivation, they were able to stimulate the experts' teaching processes and to solicit deliberate explanations and demonstrations from experts (12.13). In this way, learners' could influence the extent to which they benefited in the role of student.

Experience and expertise

General as well as domain- and case-specific experience and expertise were deemed crucial to determining to what extent and how doctors learned in consultations. The younger doctors were and the less experience they had, the more relevant consultations were deemed to be for their learning (13.12). This association was particularly apparent for cases of a type with which a doctor was confronted for the first time (14.01). The learners' specific levels of experience and expertise also shaped their roles; the more experienced they were and the more confident they felt in evaluating a case, the more self-directed their working and learning (as actors) were. As more experienced learners involved experts less often and later, the level of the experts' support was lower (15.PO).

Less experienced doctors frequently involved experts and learned more often as 'participants' (16.PO). Similarly, learners who lacked expertise and experience also solicited deliberate teaching processes. For example, experts repeated important information and asked them challenging questions (17.14) and, thereby, placed learners in the role of student.

Expert characteristics

Personality/communication attitude

Learners' roles were largely influenced by experts' personal characteristics, abilities and behaviour. In consultations, experts were said to greatly differ with respect to these characteristics. Whereas learners' interactions with open and communicative experts were reported to be highly valuable for learning, interactions with dominant and reserved characters who did not explain the motives underlying their actions were deemed unhelpful (18.06, 19.07).

In this sense, how and the extent to which learners acted as 'participants' in consultations varied greatly from expert to expert; some experts tended to proactively invite learners to join them in patient examination and involved them actively in discussion and decision making (20.14). However, whereas some attending physicians were likely to involve themselves in consultations, others delegated this responsibility mostly to residents, who then learned as 'actors'. Some experts were even reported to discourage their own involvement through their dominant and intimidating character (21.08). These are aspects that not only deteriorate the quality of learning, but may also negatively impact on patient treatment.

Teaching abilities

Naturally, the extent to which doctors benefited as 'students' from teaching was very much dependent on the experts' teaching abilities, which also differed considerably from person to person; some experts were reported to have excellent teaching skills because they asked challenging questions about the learners' conceptions of diagnostic and therapeutic measures, and facilitated learning by providing explanations beyond those necessary for treating the patient (22.17).

Organisational and cultural influences

Hospital: size and scope

Although there were many commonalities across larger and smaller hospitals with respect to doctor–doctor consultations (23.08), doctors noted that in smaller hospitals they tended to treat patients more independently and to make decisions and solve problems more autonomously (24.08). Working and learning more often and more intensively in the role of actor was considered particularly valuable for learning (25.14, 26.11). In larger hospitals, doctors learned more extensively in the role of participant or student and benefited from the highly specialised knowledge of a large number of experts in different specialties (27.05).

Department: culture and roles

It became evident how communication and learning were shaped by different cultures within and between departments. For example, experts from some departments were likely to limit any personal interaction with the requesting doctors from the ED to a minimum. They examined patients on their own and left only written notes. In doing so, they restricted opportunities for learners from the ED to assume a participative role (28.02). Other departments, which were characterised by a communicative open culture and a less hierarchical structure, were linked to

intensive participation and the deliberate teaching of less experienced doctors (29.13).

Moreover, perceptions of the role of the on-call doctor varied widely across departments. Whereas this role was principally assumed by attending physician in some departments, it was assumed by residents in others (30.07). Although in some departments experienced residents acted as on-call doctors, in other departments residents were required to assume this role from the very beginning of their specialist training and, accordingly, needed to work relatively independently in the role of actor in the early stages of their career.

Situational influences

Patient census: complexity, urgency and patient number

Because doctors learned in clinical workplaces through working on patient cases (31.09), case characteristics were central elements of the development of clinical competence. In the context of consultations, doctors linked case complexity to their individual learning experiences. They particularly indicated that they learned from more complex and difficult cases (32.04). Moreover, the learners' roles were closely tied to case complexity: if cases were less complex, doctors tended to work and learn autonomously (33.08) in the role of actor. Increasing urgency and complexity required more and closer involvement of experts. In this context, less complex cases were also solved through telephone calls with experts; by contrast, more difficult and less straightforward cases necessitated on-site interaction between learners and experts and allowed for learner participation (34.13).

A high patient census and the associated workload negatively affected the quality of the residents' learning in general (35.02). For a doctor in the role of actor, it limited the thoroughness of self-directed examination and time for reasoning processes and the extent to which the learner could access codified knowledge (36.17). A high patient census also very much restricted the extent and quality of the participatory role by pressuring residents to continue with the treatment of other cases, rather than joining the examination by experts (37.09). It also prevented learners from listening attentively to experts (38.04) and from asking questions for clarification (39.17). For experts, a high patient census hampered the attending physicians' involvement and, therefore, limited participatory situations for learners (40.14). Similarly, the extent and quality of teaching, which gives residents the opportunity to learn as 'students', was affected by a high patient census because the latter limited oral explanations (41.10), physical demonstrations and the challenging questions asked by experts (42.05).

Time: day, night and weekend

Time as a situational influence considerably shaped learning in consultations and, in particular, the learners' roles. During dayshifts, learners easily involved experts and learned as 'participants'. During late shifts, nightshifts and at weekends, learners were required to act and make independent decisions as 'actors' more frequently (43.13), opportunities they deemed very relevant for their learning. In these shifts, learners often involved experts only through telephone calls (44.12); even if on-site support proved necessary, learners were required to manage their patients for at least some time on their own. During nightshifts, experts' motivation for teaching was reported to be lower, and, accordingly, learners benefited to a lesser extent in the role of student (45.11).

Learning effects: knowledge, skills, self-confidence and security

Learning was framed by the triangular relationship among the roles assumed by residents and doctors. In the role of actor, learners developed their own conceptions. In the roles of participant and student, they were enabled to contrast their conceptions with those of more experienced medical actors (46.06). This comparison triggered important opportunities for reflective practice in terms of reflection on action.[41] The effects of learning were described with respect to two dimensions. Firstly, learners gained knowledge and skills for future situations (46.06). In addition to biomedical and clinical knowledge, this learning involved procedural and cultural forms of knowledge and skills (i.e. *learning how we do things here*).[18,40,42] Residents learned, for example, which diagnostic processes should be conducted before a specialist could be involved, which specialists were responsible for what kind of injury (new doctors needed to distinguish similar or overlapping areas of competence, such as those of otorhinolaryngology and craniomaxillofacial surgery), and how a patient should be presented to a specialist in order to demonstrate the competences of the ED team (47.PO); these are forms of cultural and procedural knowledge and skills that may vary according to the organisational unit. With respect to communication and cooperation skills, consultations provided valuable oppor-

tunities for residents and less experienced doctors to learn how to precisely articulate patient cases; they were deliberately encouraged to practise articulation skills by more experienced doctors (48.11). Moreover, consultations offered opportunities for residents to learn and engage in important conversations with patients and family members (10.PO). Knowledge and skills were not simply reused in new cases, but needed to be evaluated and adapted according to the contextual specifics of the new situation in a process of deliberate reflection (49.09).

Secondly, the interactions also affected learners' self-confidence and sense of security. Situations in which learners' approaches and concepts were identified as identical or similar to those of experts increased their confidence and sense of security for future situations (50.02). However, learners also deemed relevant cases in which their conceptions did not equal those of the expert and would have led to potential mistakes if they had not been corrected. When the learners' sense of security and self-confidence were irritated, they indicated that these occurrences increased reflective practice, sharpened their awareness and increased their concentration in future situations (51.08).

DISCUSSION

Main findings

Although doctor–doctor consultations can offer rich and manifold opportunities for residents' learning, the occurrence of this learning, the form it takes in terms of the roles participants play and its quality are very much the result of the interplay among different contextual influences. These influences include individual factors, such as the motivation, special interest, expertise and experience of the learner, and the personality, communication attitude and teaching abilities of the expert. They also include organisational and cultural factors, such as the size of the hospital, the scope and culture of departments, and the way in which roles are organised, and situational influences, such as the number, urgency and complexity of cases, and the time of the event, which can vary across situations. The factors interact differently in every learning situation. Their interplay manifests in the dynamic assumption by doctors of any of the following three roles: actor (being responsible), which the doctor assumes by working autonomously; participant (being involved), which the doctor assumes by taking part and learning from situations with more experienced and specialised colleagues, and student (being taught), which the doctor assumes by receiving concrete instructional support in the form of explanations, demonstrations and challenging questions. According to contextual influences, learners change their roles within consultations. Over time, learning effects accumulate to general and domain-specific experience, expertise and interests. In addition, more and more learning occurs with the doctor in the role of actor as his or her career progresses. All these roles are important to learning and the development of competence. What makes a difference is the quality of learning within a particular role, which also results from the interplay among contextual influences.

Theoretical and practical discussion

Although this framework is new, some of the findings reported in the present study are in line with those of previous studies conducted in other areas of clinical or medical workplace learning. For example, learning context and culture have been reported to differ among departments[20] and hospitals.[15] With respect to patient census, learning has been very closely linked to individual cases,[15] and differences in patient census have resulted in more or less intensive learning experiences.[19] Teaching has been found (as in the present study) to be limited by time constraints.[26] Although teaching was considered very important, self-directed work, decision making and taking responsibility have been reported to provide valuable opportunities for learning.[22] Some studies have also identified the different attitudes of clinical experts towards teaching as relevant.[23,43]

The framework developed in this study relates in particular to the models created by Dornan *et al.*[21] and Boor *et al.*[20] for the learning of undergraduate students. Both groups of authors[20,21] stress the importance of individual (motivation, identity, skills), organisational (department, team organisation) and curriculum-based (schedules, learning objectives) factors and their impacts on participation and learning. In the present study, which focused on the learning of residents and doctors in loosely framed, day-to-day practices, no curricular structures were identified. Instead, the interplay among organisational, individual and situational factors represented the 'workplace curriculum' and determined the form and quality of learning. Moreover, our concept of participation did not particularly refer to legitimacy because each of the doctors involved had relatively clear roles and responsibilities. Effective learning in the settings observed involved a blending of roles in

terms of participation and, literally, 'non-participation', towards self-mastery (i.e. performing autonomously and independently in the role of actor).

According to the framework and in line with principles of situated cognition, the locus of learning is not the acquisition and retrieval of knowledge. Instead, learning occurs in the dynamic interaction of the learner's capacities and attitudes with other contextual factors in work situations. These factors do not determine learning in a linear and predictable way; they should, rather, be considered as 'preconditions'[44] which increase the likelihood that a certain interaction will occur and that a role will be assumed. Although the current framework centres on the development of the learner, it should be acknowledged that the various interactions also influence other contextual factors. For example, they shape (and can alter) departmental culture and they may also impact on an expert's development of competence.[45–47] These findings also illustrate the limitations imposed by the consideration of context as an element that surrounds the learner. Instead, we prefer to subscribe to an active notion of context.[7,8,13] We suggest that context should be viewed as the interaction of contextual factors, which evolves and changes over time and manifests in different forms (roles) and quality of learning.

From a practical standpoint, the present framework can help clinicians to better understand the complex and situational dynamics of learning in loosely framed, day-to-day practices such as doctor–doctor consultations. The framework might be used, for example, as a tool in team meetings or in mentoring to reflect current roles in learning and teaching practices. In this sense, the model can permit residents and doctors to increase their awareness of and responsiveness to the interaction among various contextual factors, and may allow them to better harness learning opportunities situated in their daily work. As younger residents benefit by taking the role of actor in consultations and by working relatively autonomously, they should be enabled to take this role in the early stages of their specialist training. However, the tasks to be fulfilled must fall within the range of the learner's competence[22] and attending physicians must be at hand to assure the quality of care, as well as to resolve questions and insecurities. The present framework also clearly demonstrates the influence of experts. Communication-related attitudes and abilities (still) appear to be very unevenly distributed among attending physicians and can very negatively impact on a learner's development of competence, as well as on the quality of patient care. In light of this, the roles of doctors as communicators[48] and, in particular, as teachers in informal work settings appear to be (still) neglected. This observation supports the claims of Epstein and Hundert,[14] who argue for more comprehensive, summative and formative assessments of professional competences, including communication skills, and, as we would also argue, related teaching skills.

Strengths, weaknesses and future research

This study is strengthened by its triangulation of data, methods and investigators, as illustrated in the combination of observational and perceptual data derived from interviews and observations, and by the involvement of doctors from many different (sub)specialties (Appendices 1 and 2), as well as by the cooperation of investigators from different fields of educational research (medical education, workplace/professional learning, linguistics, teacher education and development). The findings of this research were also strengthened by a process of independent coding, the calculating of inter-coder reliability,[49] member checking and by comparing the present results with existing theories.[35,39,49]

Although theoretical saturation was achieved within the settings specified,[34] the results are weakened by the fact that the research was restricted to one specific country and that the observation was conducted in one site only. In addition, the use of purposeful and typical sampling strategies with a wide range of cases[33] involving varying roles and different hospitals might have led to bias in the data, given the rather small number of study participants. Because consultations tend to be based on more complex cases, the research focused on medical, clinical and procedural expertise. The loosely framed and mostly dyadic consultations can be explained by situated learning approaches and are typical in interdisciplinary clinical work.[28] However, little attention was paid to learning related to networking, team processes, relationship building or identity formation in the sense of social learning theories. Accordingly, any generalisation of the results beyond the context of doctor–doctor consultations must be treated with caution. Moreover, the model is by no means comprehensive because it includes only the inner layers of the 'Russian doll-like composition,[50] of workplace factors; it does not pay attention to the broader economic, regulatory and social contexts of hospitals and the overall health system.

In view of these limitations, we suggest that future research might: (i) more explicitly consider non-

medical/clinical aspects of knowledge and skills and, in so doing, explicitly examine aspects of identity formation, relationship building, peer-to-peer learning, cooperation and psychosocial needs through the lenses of social learning theories; (ii) explore situations or units of analysis other than consultations; (iii) explore such situations in other cultural or geographical settings, and (iv) involve quantitative research methods to research the phenomenon more broadly.

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APPENDIX 1

Extracts from interviews and participatory observation

1 I have to tell him how to proceed. I can involve the attending physician but I can't do so always and for everything. There are patients for whom I make the decisions [...] Ultimately I have to decide on a therapy. That's a rather significant responsibility [...] I consider it to be positive, because one can learn more [...] One also has to read up on things; in the case of a specific fracture one has to check treatment guidelines carefully, when treatment should be surgical or more conservative, etc. This provides a great learning experience (08)

2 Yes, I consider it [being responsible] to be positive, because one learns more. Therefore I believe that it is perfectly fine, as long as you have the opportunity, to consult someone (07)

3 One can observe, how he asks questions, how he interacts with the patients, which clinical examinations he carries out, how he holds the stethoscope – there are [a] thousand possibilities – how he does the ultrasound. One can observe a lot. It is a great learning experience (13)

4 I mostly do the following: I say: we have this or that and I would this or that. Do you agree? (13)

5 These are the situations when one learns most. If he challenges you and asks probing questions [...] Then you learn the most (02)

6 For example, when he explains an operation initiation to me although none is necessary. Even during the joint viewing of a radiograph I learn a lot by him explaining exactly when an operation initiation would be necessary. That's how I learn the most (06)

7 Fifty per cent of doctors here are residents … We all want to become good doctors that's the aim (13)

8 There are some who don't join the specialist out of principle, to save time. Then there are those who think they can learn something and go along. It depends on how you set priorities (04)

9 There are people who are naturally motivated and those who are less motivated and people who are interested more in certain subjects than others (15)

10 [Participant observation: conversation between a resident and an attending physician about informing the parents of an injured motorcyclists, who are waiting in the waiting room. The resident offers to inform them without the attending physician about the health of their son and thus enters a new learning situation as 'actor'] Attending physician: Yes, I still have to talk to them Resident: Shall I do it? Attending physician: With pleasure... yes, yes, I'd like that [smiles]

11 It all depends on how motivated one is and how much one is interested in a specific case, whether one reads up on things (08)

12 As resident in the emergency department I always experienced that if one is motivated and enthusiastic and accompanies the on-call doctor – be it a resident or an attending physician – one always benefits. They are always ready and motivated, with very few exceptions, to teach or talk to you (13)

13 I think the surgical resident can learn most. In our emergency department the surgical residents are mostly inexperienced. This means they are in the first or second year of training and can learn from each consultation (12)

14 If you do it for the first time it's a completely different pressure and a different concentration. You learn an awful lot (01)

15 [Participant observation: phone call between a resident (on-call) und an attending physician who is at home] Resident: Hi, Robert [name was changed to preserve anonymity], I've got a patient here who is being treated in consult. A panel dropped on the patient's head from several meters height. She is [...] years old, she has a scalping injury [...] The question is whether we should treat her and if we do it in the large operating theatre [The attending physician asks clarification questions] No, none [...] It has peeled off like a rag, which just needs to be reattached. I have already performed such an operation in [name of a city] which was twice as large. She does not need general anaesthetic [...] In reality it has peeled off [Eventually they decide that the resident would perform the operation on his own]

16 [Participant observation: telephone consultation between an inexperienced resident and the on-call doctor about a radiology image] Resident: Mh, it is hard to describe... no temperature, no [...] the teeth are full of holes... sorry? [...] Where can I see that? Mh, no, I don't know what that should look like? It is difficult to describe... on the left it is a little sharper than on the right... where is that? [On-call doctor explains] Resident: OK, thanks, see you soon [At the end of the telephone conversation, he turns to a colleague sitting next to him] Resident: If you say you have no idea, they always come [smiles]

17 [If an emergency resident explains the case insufficiently on the phone] we ask, whether he looked at the patient, examined him, what type of fracture he has, what happened and we tell him to present the patient properly [...] Especially if we know it is someone with little experience (14)

18 There are two types: those, who do it quickly, and those, who like to explain. I learn the most with doctors who are willing to explain (06)

19 Yes, it depends on the level of stress, but also on the type, whether he is quieter and simply doesn't talk about it and says 'That's how we do it, period.' Or whether it is someone who tends to elaborate and tells you: 'I would recommend this or that.' That certainly makes a big difference. It also depends on the desire to teach, which experienced colleagues can display [...] Yes, when I look back, there can be considerable differences (07)

20 It [teaching behaviour in consultations] depends simply on the type [...] There are attending physicians who take the time and are prepared to discuss something even in stressful situations and who are willing to accept suggestions from subordinate doctors. There are others, who are relatively dominant, and handle things rather one-sidedly (14)

21 If you are afraid to call because you could be told off for doing so. I have heard that from colleagues. I was lucky that that's not happened to me once (08)

22 I had an extremely good attending physician. I learnt a lot from him because he asked me questions. For example, he said that we have this case and asked me what my main diagnosis was, and if that's correct, what was relevant for making a decision, what pathogens I expected and what antibiotic I would choose – in order to train me. He did this systematically and well. That's very person-orientated (17)

APPENDIX 1

(Continued)

23 In principle it works the same in large and small hospitals, only one has more back-up more easily to hand in a larger hospital (08)
24 In a smaller hospital one is quickly the only doctor in the house and has to manage oneself up to a certain point until the background services or the attending physician arrive who can support you if something doesn't work. Because of that there exists a certain difference (08)
25 For a career as a doctor it is of course very, very important I believe to have been in a hospital where you have to make decisions for yourself (14)
26 That's kind of when a urinary retention requires a catheter. In the university hospital you get a note and the urologist comes […] At our hospital [a small regional hospital], our residents know how it works: urinary retention, ultrasound on it, [the patient] gets a catheter [...] The guys learn something in our place (11)
27 Because of the specialisation a lot of deeper and broader knowledge is available […] (05)
28 Sometimes it is suboptimal and not at all structured. Sometimes you happen to find a note from the consultation in the file after hours. Most of them come and tell you what they would do. There are more and less communicative disciplines [...] It depends on the discipline and within that on the person (02)
29 We work together a lot. There is no big gap or a clear division. He asks questions and if I also want to ask questions I can do so. We are very uncomplicated. For example, one asks about the anamnesis or how the patient is doing. And if I think that something else is also important I ask as well [...] We have no clear hierarchy (13)
30 I get asked for advice by someone, for whom I am not the line manager, but by a resident who is a colleague. That is something I don't know from my previous post. There the attending physician from the specialist discipline was the first port of call (07)
31 You can memorise it better if you can link it to a specific case and if one learns it in a particular situation (09)
32 […] Interviewer: The more complex the case, the...
Interviewee: … the more potential for learning exists (04)
33 Everything else that's not severe, I look at myself, think of a diagnosis and treatment, collect all the data and pass them on […] It all depends on how severe a case is (08)
34 For the difficult things they [attending physicians] always come (13)
35 I think that this is of great importance. The problem in the emergency department is that there are too many patients, too little time, too few doctors! It means that unfortunately learning and teaching are relegated (02)
36 Yes, of course, if you have time. I have had six doctor-to-doctor consultations in one afternoon and then I look up nothing (17)
37 If there is time, we look at him together. It means, if you don't have other patients requiring urgent attention (09)
38 Lack of time weakens the relationship with the on-call doctor if one doesn't listen to him properly (04)
39 If I have time, I ask the other attending physicians, and if I don't have time, then I don't ask (17)
40 Sometimes then the attending physician is available – which is not always the case – he may come by to have a look (14)
41 I notice by looking at myself [resident, on-call], that we don't tend to have much time. It takes time, to explain something. Sometime we don't discuss the case or the topic (10)
42 If a lot is happening in the emergency department, then it [promoting the explanation of residents] tends to be difficult and the residents are glad, if they can just carry on (05)
43 During the day, between seven thirty and five thirty, the attending comes along [...] That's just not possible during the late shift, night shift or on weekends (13)
44 One can solve quite a lot on the phone [...] And afterwards during late shift it [personal involvement of experts] would be good, but it should be alright without (12)
45 And at night at 3 am, awaken from deep sleep, it is rather difficult, to teach this to the residents quickly. One is pleased if treatment can be relatively quick and one can just go to sleep again (11)
46 One makes one's own concept, how one would proceed. After that the specialist comes who confirms it or improves on it. This leads to learning taking place. There is a broadening of one's horizon [resident]. Or they give you further advice, so one knows for the next time. One can optimise everything (08)
47 [Participant observation: an attending physician explains to a resident in the emergency department how the case is to be presented to the on-call doctor from the other discipline for it to be accepted by the doctors involved]
Attending physician: Patients with joint defects, stage 3, swelling, pain, both sides, patient cannot sleep [...] We from the emergency unit have to sell the case in a way that he accepts it. We from the emergency department have to present it like that to the on-call doctor
48 And I'll sometimes ask for the fracture to be described on the phone, although I can see it. Because they [residents] have to learn it like a separate language, that's very important (11)
49 If one encounters the situation again – of course, not every patient is the same – one becomes aware that one has seen this before and can remember, how one proceeded. Then you have to see if there are any reasons not to do the same again (09)
50 If I am confirmed in my findings I gain security for the next case. I know then, that I know what I do. I can really take it at face value. My findings have certain reliability. That is great (02)
51 If one comes up with something wrong or misses something and has it pointed out, be it an examination, which one did not consider or doesn't know about, or an incorrect line of thought concerning the procedure, one learns through mistakes one would have made if one hadn't conferred with a colleague […] One remembers that for the next situation (08)

Learning and teaching processes in clinical Work and problem solving

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ABSTRACT

Background: While most research has been conducted on cognitive aspects of learning and problem solving, little is known about how cognition and learning are inherent in social processes of medical and clinical work.

Purposes: This study attempted to address the question of what constitutes learning in clinical workplaces from socio-cognitive perspectives.

Methods: A qualitative study interviewing residents and attending doctors from four different hospitals was conducted. Participant observation was carried out at one site. A framework was developed iteratively and validated by study participants and experts from across different fields of (medical) education.

Results: The framework shows how effective clinical workplace learning results from the interplay of complementary, highly dynamic, reciprocal and mutually reinforcing learning and teaching processes.

Conclusion: The findings are of theoretical relevance since they build on, and further develop typologies of informal and situated learning in the clinical context. From a practical perspective, the framework can be used as a good-practice guide to inform learners and experts to the manifold and interrelated learning and teaching processes in consultations and in other day-to-day work situations.

1 Introduction

While much research has been conducted on cognitive aspects of problem-solving and clinical reasoning[1,2], relatively little is known about how cognition is inherent in social practice in clinical work. In connecting social and cognitive domains for understanding clinical workplace learning, research can be informed by theories from the fields of informal and situated learning; two approaches which comprise social as well as cognitive stances. [3,4]

Informal learning is a very broad and widespread phenomenon in lifelong learning and in adult education. It is more prevalent than formal education.[5] In workplaces informal learning is closely tied to learners' social interactions with colleagues.[6,7] Eraut developed a typology, which proposes different social and cognitive learning processes. By classifying them with respect to their proximity to work, he distinguishes learning (a) as a by-product of work such as problem-solving, (b) within work processes such as asking questions or reflecting, and (c) at or near the workplace such as being coached.[6] In medical education, Swanwick suggests to shift the focus of informal learning from cognitive to social and cultural perspectives.[3]

While *situated learning* theories place centrality on learning as constitutional element of ill-structured, real-life problem solving in social settings, they are also strongly rooted in cognitive domains [8]. Cognitive Apprenticeship, as an approach to situated learning, foregrounds six teaching and learning methods: *modelling*, *coaching*, *scaffolding, articulation*, *reflection* and *exploration.* In the medical domain, situated and informal theories of learning are increasingly used and deemed suitable to explain learning and collaboration that occur in constantly changing "real-life" workplace environments [4]. In clinical workplace learning, the focus has been put on learning through team work [9-11] or learning in educationally structured mentoring relationships.[12-14] Considerably less attention has been paid to learning in more loosely connected, one-to-one interactions without elements of formal and planned learning and teaching. These situations are, however, typical phenomena of clinical practice, in particular in interdisciplinary settings.[15]

In this respect, the literature has also little to say about *doctor-to-doctor consultations*[16], a common interdisciplinary work practice, where a (requesting) doctor refers to on-call doctors from other (sub-)specialities.[17,18] The on-call doctors are often residents, who need to involve their attendings in case of further questions. In the literature, the educational value of doctor-to-doctor consultations has been discussed as a by-product of other focal points and has been more a matter of speculation than of empirical investigation.[19,20] Recently, a study used the "methods" of cognitive apprenticeship (CA) to analyse learning in consults. While the methods of CA served as an adequate starting point for understanding clinical teaching processes, they were limited, for example with respect to disjunction, sequencing and comprehensiveness.[21]

2 Methods

2.1 Research question, sampling and data collection

The main goals of this research were to

- (1) identify learning and teaching processes and
- (2) explore relationships between and the interplay of these processes

in clinical problem solving such as doctor-to-doctor consultations from a socio-cognitive perspective. The analyses were centred on consultations between the ED and other specialist departments because of their frequency and variety.[16-18] By including persons and roles normally involved in consults, we applied typical and purposeful case sampling.[22] Data collection was initiated by brief field study of 16 hours of observation in one university hospital in Switzerland from May to June 2010. Subsequently, seventeen doctors in four different hospitals in Switzerland were interviewed between January and July 2011. The sample included 13 residents and 4 attending doctors, 11 male and 6 female; 7 of them worked in the emergency department and 10 were physicians from other departments who took the role of on-call doctors. The doctors' specialism included general, hand and plastic surgery, orthopaedics, internal medicine, pathology, nephrology, infectiology, geriatric medicine, accident as well as emergency medicine. The interviews took place in two large university hospitals, one cantonal and one regional hospital.

The interviews were centred on in-depth discussions of doctor-to-doctor consultations, including processes (variations), roles and responsibilities, influencing factors, patterns of interaction and tools. The question of whether and, if so, how the participants perceived consultations as valuable for their learning was addressed in a second part to avoid bias with respect to what respondents typically associate with formal classroom-based learning.[6,7]

Finally, a second field study was conducted at one site, a larger university hospital, from March to May 2012, including 60 hours of direct observation of consultations between doctors from the ED and other specialist departments.[22,23] The observation of doctors was largely non-intrusive since they were used to interns and other staff shadowing them. During the field studies, observational data in the form of hand-written field notes were entered into the qualitative software Nvivo immediately after leaving the clinic. Observation was ended at the point of saturation, when no new findings emerged from data collection.[22]

2.2 Analysis and validation methods

All the interviews were audio-taped, fully transcribed and analysed along with the field notes using the software Nvivo. Data was inductively analysed, following principles of inductive category formation as a procedure of qualitative content analysis according to Mayring.[24,25] In doing so, we basically determined the level of abstraction of categories as social and cognitive learning and teaching processes in the context of doctor-to-doctor consultations prior to the analysis. One researcher (CP) worked through the whole material and iteratively identified categories. A second researcher (NP) analysed 20% of the transcripts. Together with the third author (UG), a medical doctor and insider in two of the clinics, they agreed on a coding scheme and iteratively developed a framework. Differences in interpretation were discussed until consensus was reached. With respect to intra-coder reliability the whole material was re-read and coded by CP after the development and discussion of the categories. Inter-coder reliability was ensured in that 20% of text fragments were randomly double coded by another researcher, who was not an author of this study. Upon discussing ambiguities[26], all nodes and sources achieved an agreement > 90%.

According to principles of respondent validation, participants were invited to comment on the preliminary results; and, similarly to Sheehan et al.,[27], the tentative framework was presented to and

critically discussed with a group of experts, both researchers and practitioners with a background in medical education. Suggestions from the experts led to minor amendments. [28]

2.3 Ethical considerations

Ethical advice was sought from the regional ethical review board. The committee decided that on the basis of the research concept and procedure that no further ethical approval was required. In addition, ethical advice was also obtained from a specialist outside the research team, who was professor for ethics at a Swiss university. Confidentiality of participants was ensured. For the interviews written consent was obtained from all interviewees before the interview; and all of them allowed conversations to be audio-taped. For field observation an ethical code of conduct was elaborated according to principles suggested by Morse and Orb et al.,[29,30]

3 Results

In the following sections, we present a framework that emerged from data analysis. It involves learning and teaching processes and their interplay in the context of consultations (Figure 1).

3.1 Exploration: reason, examine and access knowledge

In general, many doctors and residents worked relatively independently with high degrees of autonomy and responsibility in the settings observed. This was also true for more complex cases, prior to consulting more specialized and experienced doctors (in the following shortened to *experts*). In these situations, they mostly engaged in the following exploratory work and learning processes: **Reasoning (i)** involved a number of thinking and decision-making processes based on the interpretation of clinical evidence, anamnesis or laboratory-analysed findings and other information of a specific patient case. Even before being confronted with the patient, for example on their way to the ED, doctors had mentally started to engage in problem identification (diagnosis) and problem solving processes (therapy).

- *You develop a concept, what the next steps would be like and what suggestions one would make. (resident)*

Similarly, consultations implied decision-making in the form of minor and major judgments regarding diagnosis and therapy. Decision making without the immediate support of experts was considered as challenging but highly valuable for learning.

Closely tied to reasoning processes were self-directed **patient examination** and **treatment (ii).** This included diagnostic actions such as physical examinations or carrying out anamnesis as well as first therapeutic practices and was considered a very important aspect of learning:

- *At our hospital, our assistants know how it works: urinary retention, ultrasound on it, [the patient] gets a catheter. [...] The guys learn something in our place. (attending)*

In the context of a consult, before and while treating patients, and often before involving experts, doctors **accessed codified knowledge (iii)**[31] in the form of internet sources, books or medical lexica. In doing so, they linked and adapted new codified knowledge to specifics of the current situation and case. While they indicated not memorizing all details of an information search, they reported remembering key aspects and being able to apply such knowledge and skills to new cases:

- *The context does not get retained [when reading], but the specific therapy for exactly this patient is retained and remains available for new cases. (resident)*

In exploratory learning, doctors combined their knowledge, for example similar cases they examined in the past, or theoretical knowledge, with new information, i.e., with data from the actual case or with codified knowledge from books and the internet. In doing so they "situated" conceptions to the specifics of the case and thereby developed new conceptions **(iv).**

3.2 Involvement: articulate, take part, observe, listen and ask questions

When doctors decided to involve experts in a complex case, they were required to **articulate (v)** their developed conceptions on the problem and possible solutions via phone or face-to-face. In this sense, articulation bridged the processes of exploration with those of involvement. Articulation was closely associated with learning because it required learners to prioritize, condense and externalise conceptions in the form of a synthesis:

- *I think one learns already during the telephone conversation […]. One has to prioritise information, weigh it up, relate it to laboratory values and other examination findings and develop a first synthesis. (attending)*

The value of articulation for learning, which is not restricted to speech but also includes the use of hands, body or gaze is acknowledged and has been the subject of some discussions in the context of medical education.[32]

In order to further benefit from consults, doctors were – to a certain extent – able to bring in and take part in situations with experts such as (joint) patient examination or (de)briefing. In busy work environments such as clinics this necessitated deliberate and pro-active efforts on the part of learners. **Taking part (vi)** in situations with experts then allowed for multi-modal learning processes such as **observing (vii)** and **listening (viii);** situations where learners experienced experts' mental conceptions. Accordingly, doctors outlined the importance of learning through observation of experts during patient examinations:

- *If one wants to internalise something, one has to come along. Otherwise one doesn‘t retain things. It is always good to come along and to observe how superiors do things is also very valuable. (resident)*

Doctors also reported learning *by listening to experts*. Oral information on patient-treatment, which was either directly addressed to them or questions and explanations to patients, was relevant:

- *[As resident who is joining a specialist in a consultation] one can simply listen, and learn a lot in that way. In part one hears new things. (06). For example, I can hear what questions are being asked in order to be able to distinguish certain things. (resident)*

By **asking focused questions (ix)** on the patient case and thereby showing motivation and interest, learners were able to stimulate teaching processes of experts. In this way, they were able to turn a situation of involvement into one of teaching.

- *I think they [consultations] have a lot of learning potential, because I often demand. Since you get a lot said. (resident)*

In contrast, a lack of interest and motivation from the learner was said to discourage and even stop teaching efforts.

3.3 Teaching: promote articulation, demonstrate and explain

From a learning perspective, day-to-day consultations were considerably enhanced if experts engaged in deliberate teaching processes beyond the immediate requirements of the patient treatment. Learners particularly valued situations where experts **promoted** the **articulation (x)** of their conceptions by asking challenging questions on the underlying reasons of diagnoses or therapy. This facilitated their engagement with the case and involved them more centrally in the patient treatment.

- *I learnt a lot from him [attending doctor] through the questions he asked me. He […] asks, what my main diagnosis was, and if that's correct, what was relevant for the decision, what pathogens I expected and what type of antibiotic I would choose – in order to train me. (resident)*

Participants indicated that they also benefited very much from extensive and in-depth information from experts: **oral explanations (xii)** that included the underlying reasons, explaining how and why a specific measure or a course of action was performed. These accounts entailed to some extent theoretical knowledge, which was, however, solution-oriented and closely linked to the specific case and situation. These in-depth information supported learners very much to re-use the knowledge in new situations. Of particular importance were personalised explanations: direct feedback and information that were provided upon learners' articulation of their conceptions regarding patient cases. Then, explanations entailed precise advice which confirmed, complemented or challenged learners' conceptions.

The following sequence provides information from a conversation between an expert and a resident. Before this situation, the resident had presented the patient case, and he and the attending doctor had agreed on the diagnosis (pancreatitis) and further treatment. Now, the attending promotes further articulation in the form of questions about the (hypothetical) situation that the patient would need to be sent to the intensive care unit – in order to teach the resident; a situation, which clearly went beyond the immediate requirements of the treatment.

- *Attending: From what point on do you move a pancreatitis to the intensive care unit? What is the reading?*
- *Resident: Pathological pancreatic amylase values.*
- *Attending: Yes, but what is the criterion, when would you say s/he needs to go to the ICU? Just when you did not previously calculate it, you are called to assist and consult the lab results, what are you looking for? Amylase is good; the second point is …*
- *Resident: yes, amylase, lipase, pancreatic enzymes in general ...*
- *Attending: Yes, but what else?*
- *Resident: a Glascow score [pause], uh, sugar*

- *Attending: exactly .. the second point, very importantly, is sugar, hypoglycaemia, yes. And the third point is [pause .....] CRP. CRP greater than 150 and you can say goodbye and straight to the ICU.*

This extract makes clear how the attending first challenged the resident by asking questions about diagnostic eventualities. Eventually he provided supportive, supplementary and very personalised feedback upon the learners' conceptions. This excerpt also shows how closely interwoven and interlinked learning and teaching processes are in consults.

Effective teaching of clinical knowledge and skills was not only based on oral explanations, but included physical/bodily **(xi) demonstrations and gestures.** In the context of consults, experts demonstrated less experienced doctors and clerks how to handle instruments, for example how to use a tool in order to perform a streptococcus test. They also showed how to examine or physically treat patients. For this, they performed the examinations directly with the patient and explained the procedure to the learners; or they used their own bodies as knowledge representations to demonstrate procedures of patient examination such as correct knee examinations. They also pointed to specific parts of their body when they wanted to underline focal points of the current discussion or to show specific anatomic positions precisely; for example, to demonstrate where exactly the pain was located. And, experts also used mouse gestures and their fingers to accentuate aspects of external representations such as X-rays on (computer) screens. The following situation describes an on-call doctor who is sitting with a clerk in front of a computer in the context of a consult. The on-call doctor explains a dental X-ray to the clerk. During his explanations he encircles the respective focal points of the discussion on the X-ray with the mouse cursor. Suddenly he says:

> *"This is a strange thing ... the nerve is interrupted."*

He lets go of the mouse, and points directly to the relevant point on the screen with his hand.

> *"Here you can see the superimposition of the tongue ... here you can see the defect, whatever that is ...."*

He continues to point at the spot with his finger.

> *"You can trace the three channels at the sixth (tooth). It can contain many bacteria. At the eleventh one can't see any ... There's pain on tapping.*

The consultant emphasizes the statement by tapping with one hand to the other:

> *"It's could be odontogenic sinusitis ..."*

This excerpt again shows how interwoven the teaching processes were: the on-call doctor used gestures to synchronously connect speech with the visual structures of the X-ray.

3.4 Mental and embodied conceptions: reflect and learn from (near-miss) errors

Learning and problem solving in the context of consultations involved considerable meta-cognitive processes centred on the notion of **reflection (xiv)**. Learners described how they compared their own approaches and conceptions they developed through *exploration* (iv) of those of experts, which became explicit through the categories of *involvement* and *teaching* (xiii). This reflective comparison,

or, using the words of Schön, "*reflection on action*" [33,34] reinforced or changed the learner's conceptions. Reflection on, and changing of personal conceptions were, in part, a systematic and conscious process. Learners reported to deliberately choose experts they accepted as role models and from which they learned. Learning and reflection was particularly encouraged in cases where the conceptions of the experts differed much to those of the learner's (for example in the case of incomplete conceptions or misconceptions or 'near-miss errors').

- *Cases, where one notices or is being shown, that one has made an erroneous estimation, have the greatest learning effect. (attending)*

3.5 Future impact of teaching processes

Existence and quality of teaching processes did not only affect learning in the respective situation, but also impacted on exploration and involvement of the learner in future situations. It was reported that, if learners benefited from rich teaching processes, they were likely to engage in thorough **future exploration (xv).** By contrast, if they received poor teaching, they became demotivated and tended not to perform a detailed exploration – prior to involving the expert – the next time:

- *Because it is highly unsatisfactory from an emergency department perspective when they only get the feedback that this is to be done and that's it. Then as an ED doctor one doesn't have any desire to make an effort. Specialists can have a very demotivating effect on those working downstairs [in the ED] that they have a good initial look. (resident)*

Similarly, existence and quality of teaching also influenced **involvement** of learners in future situations (xvi). Good teaching motivated learners to take part more often in situations with experts – in some cases even if they needed to compensate this time with additional working hours.

- *If you notice that you can benefit a lot from the on-call doctor, then you accompany him/her more often. (resident)*

4 Discussion

4.1 Main findings

The main contribution of this research is shedding light on the dynamics between learning and teaching processes. That means, according to the framework developed, to the interplay of the processes of exploration, involvement and teaching. Learning associated with these categories is not separate or complementary, but occurs in the form of reciprocal, highly dynamic, interwoven and mutually reinforcing processes in the flux of the individual situations and beyond. We have shown how doctors engage in self-directed and autonomous forms of learning and problem solving including *reasoning (i), patient examination (ii)* and *accessing codified knowledge (iii)* (**exploration**). In exploratory processes learners' situate mental and embodied conceptions according to the specific requirements and characteristics of the case and thereby develop personal, situation and case specific conceptions (iv).

In order to call in an expert, learners need to *articulate* (v) their understanding of the case and may then arrange taking part in situations with the expert (vi). Thereby they learn through multimodal processes such of *observing* (vii) and *listening (viii)* (**involvement**). Being involved, learners can

encourage experts' teaching processes by showing their interest and motivation in the form of *focused questions (ix)*. Effective **teaching** of experts consists of processes that go beyond the necessities of the immediate patient treatment. This includes *promoting* learners *to articulate* (x) their understanding of the case by asking challenging questions and then engaging in physical or gestural *demonstrations* (xi) and oral *explanations* (xii). Processes of involvement and teaching make the experts' conceptions explicit and allow learners to contrast those with their own (xiii). This reflective comparison (xiv) reinforces or changes learners' conceptions.

The processes are strongly interconnected. While *articulation* bridges the processes of exploration with those *of involvement, asking focused questions* is able to shift situations of *involvement* to those of *teachin*g. Existence and quality of teaching do not only impact immediate learning processes, but also affect learners' future exploration (xv) and involvement processes (xvi).

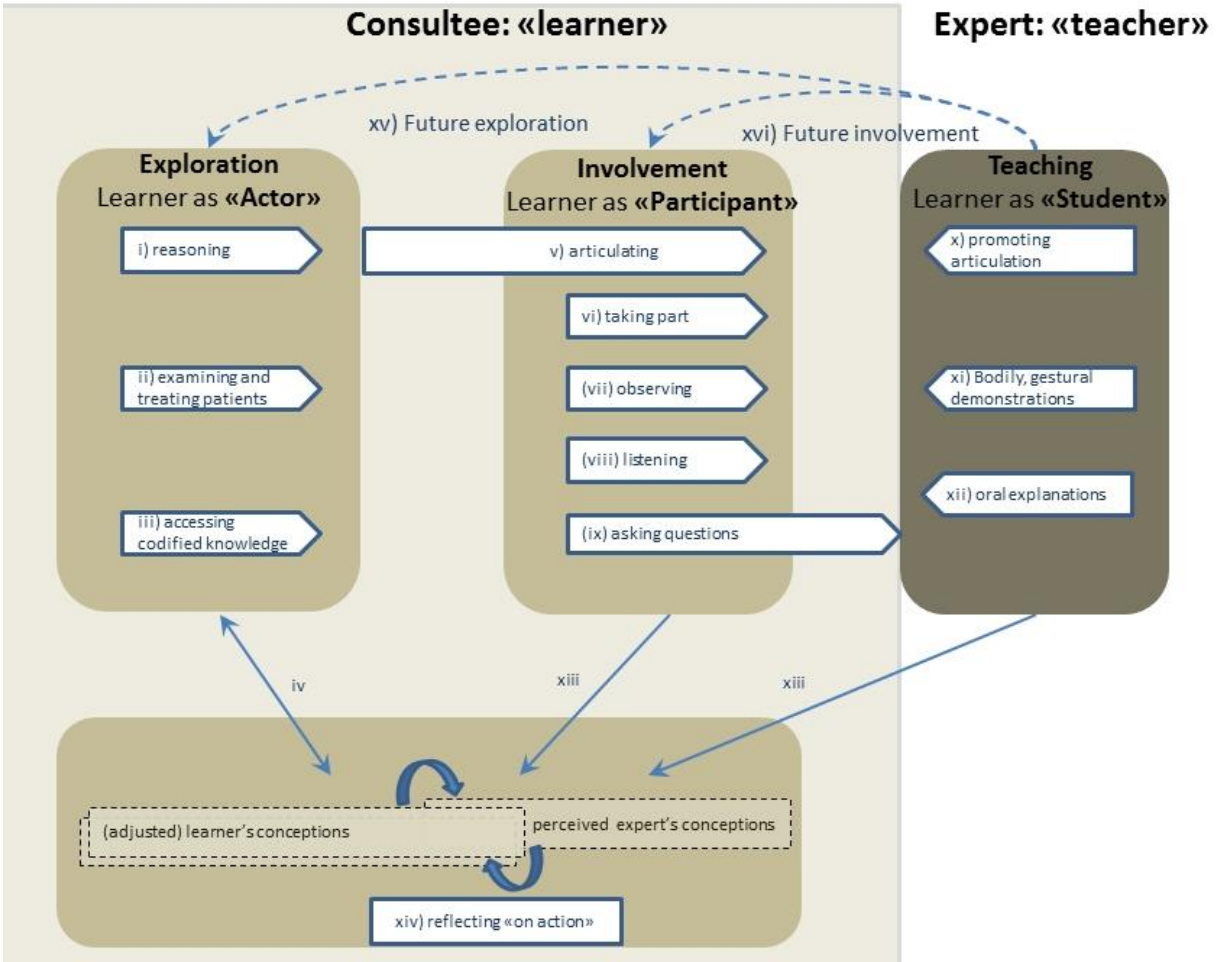

Figure 1 The interplay of learning and teaching processes

4.2 Related literature

The identified categories and processes link cognitive with social domains and relate to a number of previous studies and theoretical concepts from other areas of medical and clinical education. For example, some work points to learning by individual problem solving[35,36] and through performing of clinical activities [31,37] and to the importance of participation/involvement in clinical practices.[38-40]

Also, the role of reflective practice as well as the opportunity to make mistakes has been underlined [39,41]. The overall patterns identified can be compared to Eraut's typology. According to his typology, exploratory processes can be considered as rather implicit ways of learning and, in this sense, as a "by-product" of work; involvement, and in particular teaching processes, may entail more recognised learning and teaching processes were the prime object is learning [6]. They require learners to more proactively engage in and act on, and experts to deliberately perform teaching processes beyond the sole treatment of a patient. Accordingly, consultations, which Eraut considered as one specific process and subsumes under "work processes with learning as a by-product", constitute, at least in the medical profession, a much broader concept and can include a variety of implicit and more deliberate learning and teaching processes. Unlike the framework developed here, Eraut's typology does not explain the dynamic interrelations between learning and teaching processes, which are typical in dyadic interactions in clinical workplaces.

This framework shares important processes such as reflection, articulation and exploration with the model of cognitive apprenticeship; but CA does not recognise the manifold processes of exploration distinguished in this study and, more importantly, it does not describe the dynamic interdependence between learning and teaching processes – an aspect which is, however, typical for learning in consultations and in clinical practice.[21,42]

The model developed here reflects to some extent also the interactions in the conversational framework of Laurillard, which she developed out of the analysis of formal educational contexts [43]. Laurillard foregrounds changes of conceptions and of "conceptions of practice" and exemplifies associated conversational learning processes. Her intention is to cover a bundle of different learning theories and to provide a framework that can be used to test the "the true value to learning of any particular teaching method". Our approach is rather explanatory in nature in that we identify and group specific socio-cognitive learning and teaching processes in clinical problem solving and describe their interplay. Both frameworks illuminate, however, the complex interrelation of learning and teaching processes and their impact the level of learner conceptions.

4.3 Significance and practical implications

The most basic finding is that doctor-doctor consultations should not exclusively be perceived as the outsourcing of parts of the patient treatment to specialist doctors, where the focus is on consultation patterns, efficiency and outcomes.[16-18,44] Consultations *can* entail extremely relevant educational processes. Effective learning in consultations is, however, not an automatic side effect. In the same way, the framework does not entail standard but rich and multi-faceted learning and teaching processes. Accordingly, it can be used as an example of good practice to be matched against real practices and habits of both learners and teachers. In doing so, strength and weaknesses of current processes can be identified and possible gaps can be addressed in order to more deliberately harness consultations for learning: learners can enhance the educational value by pro-actively elaborating and articulating thorough (and relevant) conceptions of patient cases to allow for personalized feedback. They can show their interest by accompanying the expert and by asking focused questions—and thereby further stimulate teaching processes. Teachers may promote learners' articulation by challenging questions instead of immediately suggesting a solution; and then provide focused feedback. In doing so, they should pay attention to make their underlying reasons of a decision

explicit; this should be done by using gestural demonstrations where speech alone is insufficient for less experienced members of the community. With reference to Dillenbourg[45], learning in consultations does not require cooperation, where individuals perform sub-parts of the work in isolation and finally assemble these. Effective learning means *collaboration*, where problem solving is jointly conducted, permitting the less experienced doctor to contribute and to compare personally elaborated conceptions with the ones of experts. It should be also noted that no category should be prioritized over another, but effective learning only takes place when the learner contrasts the conceptions s/he elaborated through exploratory forms of learning with the expert's conceptions that are made explicit by the processes of involvement and teaching.

4.4 Limitations and future research

The study has a number of limitations: There might be sample bias because the research involved different cultural settings within only one national context. Also, the framework focuses on the perspective of the learner. It can be assumed, however, that the conceptions of the experts, in their role as teachers, will change over time (see for example Laurillard[43]). Also, the findings are elaborated on the analysis of consultations. Accordingly, future research may explore to what extent the concepts identified can be also applied in other medical and clinical situations.

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Abstract
In the medical profession much knowledge is embodied as well as socially, temporally and culturally distributed and clinical workplaces are characterized by intensive use of technological instruments. Viewed from this perspective, surprisingly little use has been made of the theory of distributed cognition (DCog) which places centrality on how, over time, cognition is distributed in an overall system in the form of representations between and across internal and external (material or environmental) structures.

Drawing on, and extending the DCog perspective, this paper discusses how multimodal representations which are (1) interwoven, (2) co-constructed, (3) redundantly accessed, (4) intersubjectively shared and (5) substantiated can contribute to learning and meaning making. It is intended to add to the educational discourses about distributed cognition and, more importantly, to broaden the understanding of practice and learning in clinical workplaces. The authors posit that future work should pay more analytical attention to the ways medical and clinical actors use and connect gestural practices, such as movements of hands, arms or trunks, along with visual and haptic structures of their own bodies and of artifacts, such as technological instruments and computational devices, in order to construct complex, multimodal representations. In so doing, it is argued that analysis needs to dynamically "zoom in", in the form of fine-grained, moment-by-moment analysis; and, at the same time, "zoom out" and follow the ways how cognition is distributed and transformed in the form of representations in an overall system in order to develop a more integrated view of clinical workplace learning.

It is widely acknowledged that in the medical profession knowing is socially, culturally[1-3], spatially and temporally distributed between actors and their environment.[4-7] Accordingly, the understanding of medical education and practice has been extended from classical behavioral and cognitive stances[8], and increasingly takes socio-cognitive, social, cultural-historical and situated learning perspectives into account.[1,9]
However, though, in the medical profession much knowledge is embodied[10] and clinical workplaces are characterized by intensive use of technological and computational instruments[11], these aspects tend to be neglected. Similarly, to date, only a few theoretical contributions discuss how knowledge is distributed across clinical systems by means of mediating (technological) artifacts, for example by means of cultural-historical activity or complexity theories.[12,13]
A theoretical framework that addresses and integrates these dimensions is distributed cognition theory (DCog). DCOg was elaborated by Hutchins and colleagues.[14-17] Their framework places centrality on how cognition is distributed in a system in the form of representations between individuals (e.g., speech, gazes, and gestures) and in the physical environment, for example in technological instruments and computers. [1]

In the remainder of this paper we briefly characterize the main tenets of distributed cognition. Then we discuss five characteristics of representations and their value for learning. Finally, we suggest

[1] There is also other work that describes the social, cultural and artifactual distribution of knowledge.[18] We build our arguments on the framework of Hutchins and colleagues, since it makes particular reference to process perspectives and to the affordances of artifacts and also acknowledges the importance of gestural practices; aspects we deem highly valuable for the clinical context.

directions and discuss implications for future analyses. Although this paper is conceptual in nature, we exemplify the main arguments with selected empirical examples from our research; we draw from a number of studies in four hospitals in Switzerland that included participant observation, interviews and focus groups with the goal to research communication and learning of medical students and doctors. The research was conducted according to established ethical procedures and standards.[2]

The distributed cognition approach

Like any other cognitive theory, distributed cognition takes its theoretical and analytical basis from the cognitive sciences and attempts to explain cognitive systems. The difference lies in the definition of the boundaries of a cognitive system. Classical cognitive approaches typically analyze how information is mentally processed and represented.[8] By contrast, in distributed cognition, a cognitive system goes beyond the individual's mind. It is argued that individuals constantly create external scaffolding and off-load cognitive efforts whenever practical to (technological) artifacts in their environment and thereby create a tightly coupled, cognitive system.[16,17] Accordingly, studies centered on DCog analyze the use and transformation of representations in technological artifacts[19] such as spread sheets,[20 21] airspeed indicators[22 23 17] or very simple tools such as door handles[24] in great detail.

Beyond the study of individual artifacts, DCog places centrality on how cognition is distributed in an overall system that is itself considered a cognitive element.[14] This makes DCog suitable to explain complex systems and organizations such as (clinical) workplaces. As a consequence, many of the studies about DCog examine communication and coordination in workplaces. The most prominent examples include the analysis of work and collaboration practices in airline cockpits[17,22], aboard of large ships,[25] and in engineering[26] and software programming teams[27]. These studies examine processes that span different situations and, thereby, intend to identify broader, generalizable patterns.

Distributed cognition in clinical contexts

In the following section we provide an example of how three medical actors, a medical student, a resident and an attending doctor in the emergency department of a Swiss University Hospital treat a patient who hurt his knee when taking a penalty in soccer.[3] Subsequently, the example is discussed according to the principles of DCog.

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[2] Ethical advice was sought from the regional ethical review board (EKBB). Representatives of the committee decided on the basis of the research concept that no further ethical approval were required. In addition, ethical advice was also given by Andreas Brenner, a specialist outside the research team, a professor of ethics at a Swiss university who was part of a separate Swiss Ethical Board. The confidentiality of the participants was ensured. General agreements were made with the departments in the different hospitals, and prior to the interviews, written (informed) consent was obtained from every participant. All of the participants allowed the conversations to be tape recorded. For field observation, an ethical code of conduct was developed with the ethical expert.

[3] This scene was observed in the emergency department of a teaching hospital in Switzerland. An informal interview with the attending involved after the event allowed for the extraction of in-depth background information. The observer asked the attending to demonstrate the gestural practices post hoc and he took images and videos in the process. The case information was shortened and slightly modified in order to preserve anonymity and to follow the ethical guidelines that were established prior to the observation.

An example

First, the medical student questions and examines the patient in the cabin. Then she goes back to the computer terminals, where she meets the resident. She briefly presents her findings, which she then enters into the computer. A few minutes later the resident himself goes to the cabin and again questions and examines the patient. He wants to exclude a *condylus medialis* fracture and orders a radiological examination. Half an hour later, the radiological images are available in the computer system and the medical student begins to analyze them. By means of a Google image search she identifies x-rays on the internet and compares those to the x-ray in the computer system. Finally she asks the resident, who sits next to her:

Medical student*: "Can you see anything?"*

The resident looks up from the screen. (He has already analyzed the x-ray)

Resident*: "No, everything is fine, no fracture. We'll send him home. He should present himself for a check-up to his general practitioner in a few days."*

Then the attending doctor, who oversees all cases in the emergency department, comes to the computer terminal und sits down on a chair behind the student. He points to the radiological image on the screen:

Attending*: "What are we going to do with this knee"?*

At this point the resident gets involved: he turns towards the student and the attending.

Resident*: "There is no fracture. I think we should send him home and he should report for a check-up with his general practitioner in a few days."*

The attending turns to the student and asks:

Attending*: "What do you think happened?"*

Student*: "Mhh, I don't know. He hurt himself when he took a penalty.*

The student points to the spot on her own knee. The resident involves himself again:

Resident*: "He's got a burning, movement-dependent pain next to the patella."*

The attending turns to the medical student und repeats his question:

Attending*: "Ok, what is our diagnosis?"*

The student says nothing; the resident still looks at the two. At this point the attending turns his upper body towards the resident (by rotating the swivel chair) and says:

Attending*: "We need to check the tendon, something could be wrong with it. Here you can see the fluid layer which could explain an injury to the tendon."*

As he talks he points with his finger at a particular spot of the x-ray on the computer. He continues:

Attending*: "We need to check the tendon here. We need to see if the tendon is torn or fractured."*

As he says this the attending points at the relevant spot on his own knee and signals with two fingers how the tendon is positioned in relation to the knee. He continues:

Attending*: "If you make a provocation test, stretch it and abduct then he complains about pain here, right?"*

As he says this he stretches his leg and subsequently turns it to one side (abduction). In the process he points with his middle finger where he suspects a tendon injury.

Attending*: "This could be a tear of the Vastus Medialis. In any case I would carry out an ultrasound examination."*

The ultrasound examination shows that there is indeed a tear and the patient is presented to the traumatology attending on-call.

Unit of analysis: representation of cognition across a system

This example of interaction amongst doctors perfectly demonstrates the manifold ways how cognition in the form of different representations is socially, bodily and artifactually distributed: for instance, patient related information is distributed (and thereby transformed) in the form of oral language (speech), gestural practices and of the written and visual representations in the electronic/physical settings of the terminal computers (documented anamnesis, x-ray) across different actors (patient, doctors). According to Hutchins, each of these representational media holds different affordances that regulate the durability and availability of representations through time and space[17]: for example, unless recorded, doctors' and patients' speech is ephemeral; the patients' bodies and the doctors' memories are more durable and the information represented through the computer is, by contrast, relatively stable. The latter is also distributed in physical space, in that it can be accessed from many terminals, not only in the emergency department but from all over the hospital.

DCog, clinical representations and learning

Though DCog provides many interesting perspectives and insights for learning sciences, surprisingly few explicit references have been made to its value for education. In linking cognition with culture, Hutchins et al. see the (cultural) environment as a "*reservoir of resources for learning, problem solving, and reasoning*". They consider culture as a process that "*accumulates partial solutions to frequently encountered problems*" and prevents people from re-inventing solutions from scratch.[14] This illustrates that DCog understands learning as the effective performance of complex systems. From the DCog analysis of Hutchins and colleagues we know, for example, what sort of wider cognitive processes and interactions are needed to maneuver an aircraft. Accordingly, in our reading, in most of the publications on DCog, the understanding of learning is implicitly based on interactional and intersubjective epistemologies; perspectives where learning is not only based on participants' interactions, but the interactions themselves constitute learning.[28]

In the DCog literature much less has been said about learning from participatory epistemologies,[29] for example, about how inexperienced pilots would develop their competences and become full members of the professional community. (For an exception see Seifert and Hutchins[25]). Since a (clinical) system

constantly loses "relatively expert personnel", while it adds relatively inexpert personnel[25], we deem the participatory perspective also as highly valuable. In the following we would like to combine these two views in order to discuss, on the basis of the example, five characteristics of representations and their meaning for the learning of less experienced members of a clinical community.

(1) Interwoven representations

We have already discussed that, in the example, cognition is distributed in the form of verbal (oral and written), gestural and visual representations. However, the single representations alone provide limited meaning. We argue that, in particular for less experienced members of a community, meaning making and learning results from the interplay and interconnectedness of different, multimodal representations, i.e. representations using different modes such as speech, writing, images, gestures, body language, haptics and their interplay: in that the fluid (a dark spot, visual mode) was hardly visible, the x-ray alone provided very limited indication about the possible injury to the tendon, in particular for the resident and the student. This information was orally "amended" (linguistic mode, line 30) by the attending, who was, due to his experience, able to draw from a richer repertoire of multiple mental knowledge representations and of extensive case knowledge.[30] For him it would have been very cumbersome, however, to orally describe the exact spot and form of the fluid; it was his gesture (gestural mode, line 31) which, similarly, whilst providing little information in isolation, was central in linking speech with the visual structures of the representation of the x-ray.

Prioritizing one single form of representation over another would neglect the complexity of the integrated and interwoven performance and the mutual relationship of the different modes. Goodwin calls such forms of combined representations *symbiotic* and *environmentally coupled gestures* since they mutually construct a whole which has much greater value and richness than its individual parts.[31] Moreover, we also learn from the example how doctors use gestures to connect oral language with structures of their own bodies: for instance, the attending used his hand to couple oral language, where he explained what procedure needed to be applied, with visual and haptic representations and movements of his own knee (line 37-40). In so doing, he added a third dimension[32] and a complementary view to the two-dimensional x-ray representation discussed earlier. This example shows how doctors sequentially as well as synchronously integrate different linguistic, gestural/haptic and visual modes for truly interwoven and multimodal representations.[33,34]

(2) Co-constructed representations

Close examination of the example suggests that knowledge was not exclusively transmitted from the more experienced to the less experienced actor. Instead, the participants (including the learners) *co-constructed* the different representations in in a highly interactive, cohesive and self-referential format and thereby constructed participatory frameworks for learning.[31] For instance, the attending framed the learning context through the orientation of his body. At the beginning his body was only directed towards the student. By turning his body sideways (line 28) upon repeated speech of the resident (line 18 and 24), he more centrally involved the resident in the participatory framework. The cohesive nature of the representations became obvious when the attending pointed with his fingers to the spot on his own knee (Figure 1a/b). Thereby he referred to the prior movement of the student with which she demonstrated where exactly the patient felt the pain (line 23). This is far more than a gestural recipient response to signal acknowledgement and to display attentiveness; it shows gestural cohesion across turns of conversations[32] and represents a gestural "uptake" in the sense of collaborative

knowledge construction[28]: a participant (the attending) took up (imitated) the previous contribution (the gesture) of another participant (the student), and, subsequently, he did something further with it: he constructed another representation in that he extended the knee and thereby demonstrated a provocation test (line 39). These actions exemplify how cognition and meaning are constructed and co-constructed by medical experts and novices interactively and in a self-referential format.

(3) Redundant access to representations

From a process perspective, we note that, similar to ship navigation[25], in the clinical environment career development, from students to senior doctors, tends to follow the access and path of information through the system: first, the medical student, then the resident and finally the experienced attending examined the patient. This overlap produces high levels of redundancy in the system: redundancy that includes redundant access to relevant representations as well as redundant mental processing of the different actors, i.e., redundant analysis and interpretation of these representations. For example, all three medical actors individually (and redundantly) accessed the same information by viewing and interpreting the radiological image (though achieving different interpretations). Redundancy is perceived to be a particular favorable condition for error detection and robustness of complex systems[25,35] and thereby impacts the quality of the system overall. This becomes also explicit in our example: without the attending doctor's perspective (he was the third medical actor who analyzed the case), the incomplete understanding of the less experienced doctors (not considering the possible tendon rupture) would not have been detected and would potentially have led to negative consequences for the patient.

Moreover, we argue that redundancy is also crucial when it comes to learning of medical novices. As we have seen in the example, redundancy in the exploration and interpretation of patient information allows newer members of a community to independently and in a self-directed manner develop their own mental and embodied conceptions, for example by examining patients (line 1) or using internet search (line 7) and to contrast them, at a later point in time, with those of experienced doctors. Conditions which are deemed particularly valuable for learning.[36] As in the example, doctors indicate that they learn particularly well from near miss incidents, in situations where their developed conceptions might have led to mistakes had it not been for the oversight or consultation of a more experienced doctor.[36] Moreover, we would argue redundancy that allows the student to assume the role of a "doctor" in front of the patient -prior to a doctor's examination also gives them a strong sense not only of belonging to the workplace but of being a central member of a professional community.[29]

(4) Intersubjective understanding of representations

Broadly speaking, intersubjectivity includes a (partially) shared understanding as well as divergences of meaning. Hutchins and Klausen describe intersubjectivity primarily with respect to efficient communication between the pilots in a cockpit.[17,22,23] In operating an airplane, the pilots, as equal members of a community of practice, were able to build on shared knowledge and understandings and to develop shared expectations; for example, expectations about how things need to be done without making them explicit to each other: upon a request from the air traffic control system, an oral representation, the first officer responded to the captain, who has posed his question only in the form of a glance without saying anything. Hutchins and Klausen[17] argue that intersubjectivity is closely tied to the smooth and successful operation of the aircraft and is an important factor in determining the trajectory of information in the system and the properties of the larger cognitive system.

Clinical environments are different from cockpits in that they are less tightly structured and characterized by much higher levels of intra and interdisciplinary co-operation[37,38]. For example, they involve students, nurses as well as residents and doctors from different specialism; actors who hold diverse and different (levels of) knowledge and who also draw on multiple and diverse linguistic and cultural resources. These characteristics may offer poorer affordances for developing intersubjective understanding between members of clinical teams; it can lead to ambiguity, misunderstandings and breakdowns where "*an 'actor' is not achieving expected effectiveness*"[39], for example with respect to the selection of a retractor in an operating team.[40]

However, while divergence and breakdowns might, in view of a system's short-time performance, be negatively perceived, they can offer rich educational opportunities: the disruption of expectations (or, using the terms of DCog, "violated expections") with respect to the functioning of a system, may help learners to "*adopt a more reflective or deliberative stance toward ongoing activity*".[41] In the example described, the breakdown occurred when the student was not able to articulate her diagnosis (line 27). This was provoked by "*problematizing moves*" of the attending, when he repeatedly asked about diagnosis (line 21, 26) and thereby called "*something previously held into doubt*".[42] In this example (and in many others, see e.g. Smith et al.[39]), breakdowns and intersubjective divergences, served as important stimuli for learning – given that learners were able to understand the underlying reasons for the breakdown, and given that experts made their understanding explicit to them.

(5) Substantiated representations

As indicated, Hutchins and colleagues stress the importance of representations for the smooth functioning of a system, for example an aircraft. Hutchins describes, for instance, how, inter alia, speed bugs are set and used as technical artifacts to organize and ease performance in a later landing maneuver of an aircraft. He argues that by relieving scarce cognitive resources speed bugs do not help pilots to remember speed, but they rather help the *cognitive system* to remember its speed.[22] When we consider the use of technical artifacts in clinical systems, we may note that many of them are, similar to cockpit instruments, orientated towards the efficient flow of information through the system with the goal of enabling the efficient treatment of patients.[11] In the aforementioned example it could be seen that representations (e.g., the x-ray) successfully acted as mediators of collaborative work in that they supported the treatment of the patient, who was successfully referred to a specialist.

Many of these artifacts are, however, not suited to distributing and substantiating ephemeral representations over time and, thereby, allow for learning that is based on the documentation, subsequent reflection and sharing of external representations (and associated individual and collective learning experiences). For example, what if the resident and the student in the case described wanted to individually reflect on or share their experiences with other colleagues who were not co-present at that particular time? For further elaboration of this argument we consider now a statement of an emergency department doctor who points to the difficulties of sharing a representation, an x-ray, which he deemed highly relevant to the learning of less experienced colleagues:

> *This morning we had a great picture (X-ray) of a hand, very fine and not at all easy to see what there was. Of course, when the patient is no longer in the system I won't go to search again. […] I showed the picture to those who were there.*

But I have to say that if I had had it saved I'd have shown it to the newcomers as well and would have said: have a look, here …

Above we characterized speech, gazes or gestures as ephemeral. Here we can see that also representations in electronic, clinical information systems can be relatively transient. After the patient was moved from the emergency department to another station, he disappeared from the computer system. For clinical actors, in order to facilitate their learning (and the learning of the system), technical artifacts are needed that allow turning rather ephemeral representations into persistent ones that can "support reflection and interpretation" and enable members of a community to re-interpret, reflect and act on and to better develop shared understandings over time.[28] For this purpose, one might envisage tools that permit the multimedia-documentation and individual and social bookmarking of case representations.

Implications for future work

By contrasting perspectives of DCog with studies from the field of medical education, we suggest that in the future more analytical attention should be paid to gestural and haptic practices and technological artifacts and to the integration of micro and macro perspectives; arguments that we elaborate in the following sections:

Gestural and haptic practices as mediators of knowledge

First, we would like to encourage future work to explore gestural practices as part of interwoven representations and their meaning for learning more in-depth; practices which can provide, according to our understanding, not only peripheral but central modes of communication and serve as rich sources for learning of clinical actors. While we concentrated in this paper on gestures, we foreground that future work should also include other forms of representations created, for example, by postures, body positioning, visual orientation/gazes, eye movements, expressions of the face, gait or haptics etc.[34] While Heath et al.[43] focus in their paper on the affordances of video for researching clinical practice, they also provide an interesting example from the operating theatre, where an expert surgeon connects gazes, oral language and gestures to construct complex representations in the form of "interactional accomplishments" in order to teach her assistants. Koschmann & LeBaron discuss how gazes contribute to, and direct the interactions of medical students in a PBL environment[32] and Bezemer et al.[44] show how positioning and movement of upper body/trunk serves as an organizing feature of social interaction in operations. However, despite some studies in the surgical field, this remains a rather underexplored topic in medical education. Recently, Kress[10] has rightly noted that in the medical profession much knowledge is embodied and he, therefore, articulates an immediate need for theories that help to better explain notions of embodiment.

Technological artifacts as facilitators for clinical practice and learning

To date, "technology-enhanced" learning has been extensively researched in rather formal contexts, for example, how learning materials or activities contribute to postgraduate and continuing medical education.[45-47] Although clinical workplaces are characterized by intensive use of technological artifacts, much less is known, however, about affordances and design of day-to-day technological artifacts such as chirurgical instruments, whiteboards, computer terminals, phones, cameras and other computational devices for communication and learning. As one of the few exceptions, Bleakley[12] discusses the meaning of instruments such as scalpels as carriers of cultural wisdom for the medical

profession. Robin et al.[48] claim that medical educators should take advantage of the disruptive effects of new technologies such digital cameras, camcorders and mobiles that allow medical students to access and create digital information. Another example well worth future exploration is the under-theorized practice of the use of mobile medical apps for clinical professionals for practice and competence development in rather informal settings.[49,50]

Accordingly, future research should, as we would argue, analyze and theorize more in depth and breadth the affordances of the day-to-day technological artifacts for clinical learning; not as single, isolated devices but as part of the interwoven "performance" of clinical practice.

Zooming in and out: merging micro and macro perspectives

In understanding the effects of different representations for learning, it is, on the one hand, necessary to study the fine grained and subtle details on a moment-to-moment basis. Otherwise, many of the relevant aspects cannot be captured. Putting it in the words of Koschmann et al.[42] and in the sense of the interactional epistemology, understanding learning means analyzing "*doing learning*". While many studies in medical education are based on interviews, this requires observational techniques and video analysis which produce richer and more nuanced accounts.[40,43]

At the same time, attention should be paid to how the micro-patterns relate to the (changing) wider organizational or societal context. We have shown in our example how the ephemerality of individual representations in the clinical information system impeded learning in a clinical organization characterized by (increasingly) physically and temporally distributed team members. Bezemer et al.[40] connect their in-depth analysis about the formulation of requests in a surgical team to the changing, wider social and economic context: they discuss, inter alia, how the high fluctuation and turnover of clinical personnel and cultural diversity result in disambiguity and in "*far fewer opportunities to develop a shared language and pass on essential knowledge and expertise to new employees*".[40]

In merging macro- and micro-perspectives we value the metaphor of an dynamic internet map that was suggested by Evans et al.[51] They emphasize the importance of "zooming in and out" in order to develop an integrated view of (clinical) workplace learning.

Conclusions

With this paper we attempt to add to two discourses: by discussing how interwoven, co-constructed, redundantly accessed, intersubjectively shared and substantiated representations can contribute to learning and meaning making, we intend to advance the educational discourses around distributed cognition. More centrally, we attempted to make a contribution to the field of medical education in that we used DCog perspectives to point to underexplored areas of clinical workplace learning. We suggest that in order to more comprehensively understand learning and working in clinical contexts, more analytical attention should be paid to the ways how medical and clinical actors use and connect gestural practices such as movements of hands, arms or trunks with visual and haptic structures of their own bodies or of artifacts such as technological instruments and computational devices to construct complex**,** multimodal representations. In doing so, analysis needs to dynamically connect micro with macro perspectives: this means "zooming in" in the form of fine-grained, moment-by-moment analysis; and, at the same time, "zooming out" following the distribution of cognition through an overall system in order to develop a more integrated view of clinical workplace learning.

Our discussion on the use of Dcog for clinical workplace learning was based on selected empirical extracts and non-exhaustive. It also needs to be acknowledged that in other areas of social research some of these themes have been discussed more extensively. For multimodality see for example Kress and Jewitt[52,53], for gestural/bodily practices consider the work of Goodwin;[31,54] work that should be taken into account for future analysis. However, DCog appears to be a suitable starting point since it integrates many of these aspects and conceptions that have been, at present, widely ignored in medical education.

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